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(54) **LENS DEVICE AND IMAGING DEVICE MOUNTED WITH THE LENS DEVICE**

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(30) **Foreign Application Priority Data**

Sep. 30, 2011 (JP) 2011-218530

(51) **Int. Cl.**

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G02B 9/08	(2006.01)
G02B 26/02	(2006.01)
G02B 7/10	(2006.01)
G02B 5/00	(2006.01)
G02B 7/06	(2006.01)

(52) **U.S. Cl.**

CPC ***G02B 26/023*** (2013.01); ***G02B 7/10*** (2013.01); ***G02B 5/005*** (2013.01); *G02B 7/06* (2013.01)

(58) **Field of Classification Search**

CPC G03B 17/14; G03B 9/06; G03B 2217/002; G03B 11/00; G03B 7/14; G02B 5/005; G02B 5/28; G01J 3/51; H04N 5/2352; H04N 5/2353; H04N 5/35581

USPC 359/704, 825, 830, 738–740; 396/241; 348/360, 342, 221.1

See application file for complete search history.

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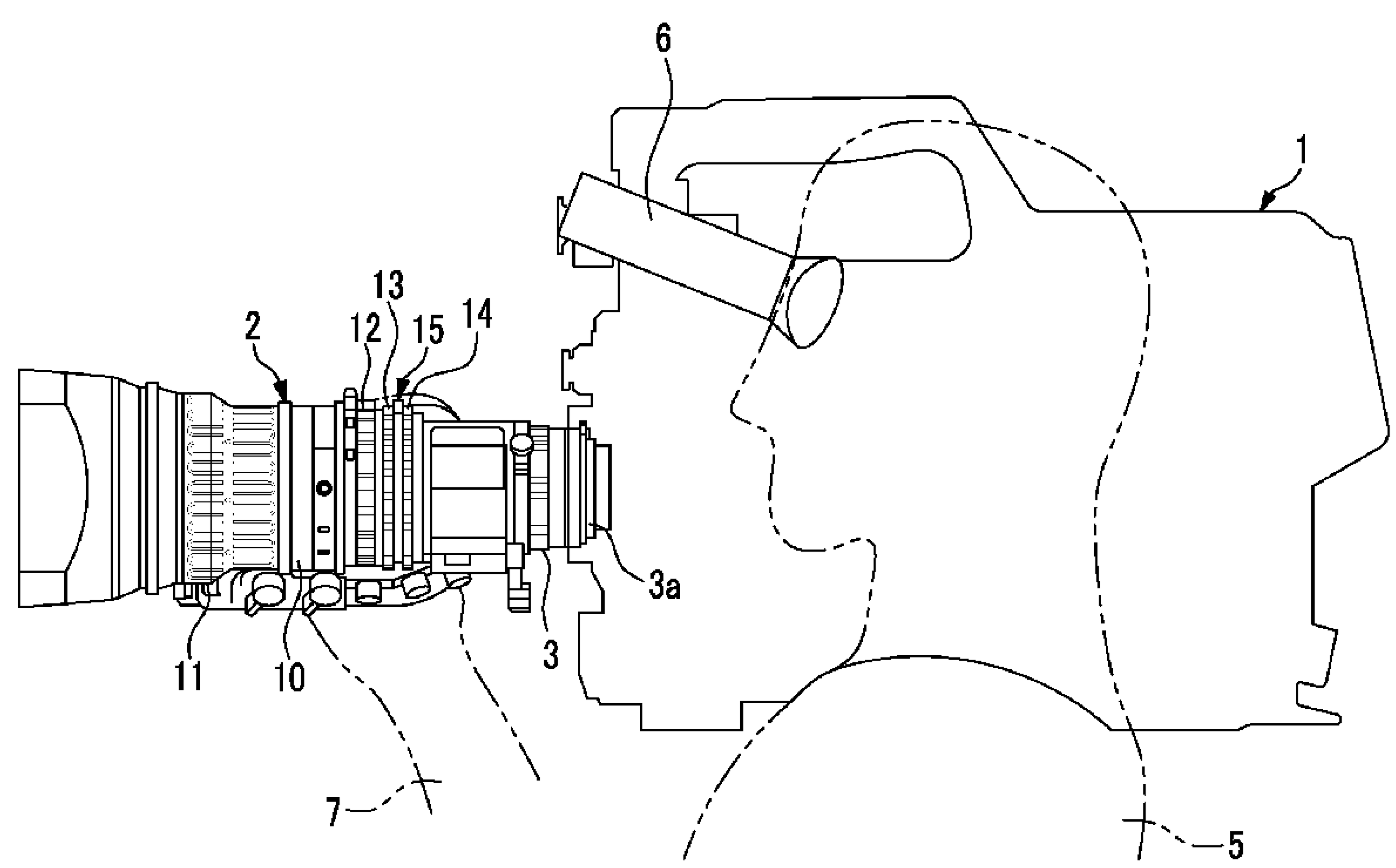
(57) **ABSTRACT**

A lens device is used with an imaging device having a imaging-lens and an aperture stop device. The lens device includes a lens barrel that houses the imaging-lens and the aperture stop device, a first operation ring that is on an outer circumferential portion of the lens barrel and that is rotatable in a circumferential direction of the outer circumferential portion about an axis line of the lens barrel in order to adjust the aperture-area of the aperture stop device, and a second operation ring that is parallel with the first operation ring and is rotatable in the circumferential direction of the outer circumferential portion about the axis line of the lens barrel in order to adjust a transmittance of a variable light transmission filter.

13 Claims, 17 Drawing Sheets



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* cited by examiner

FIG. 1

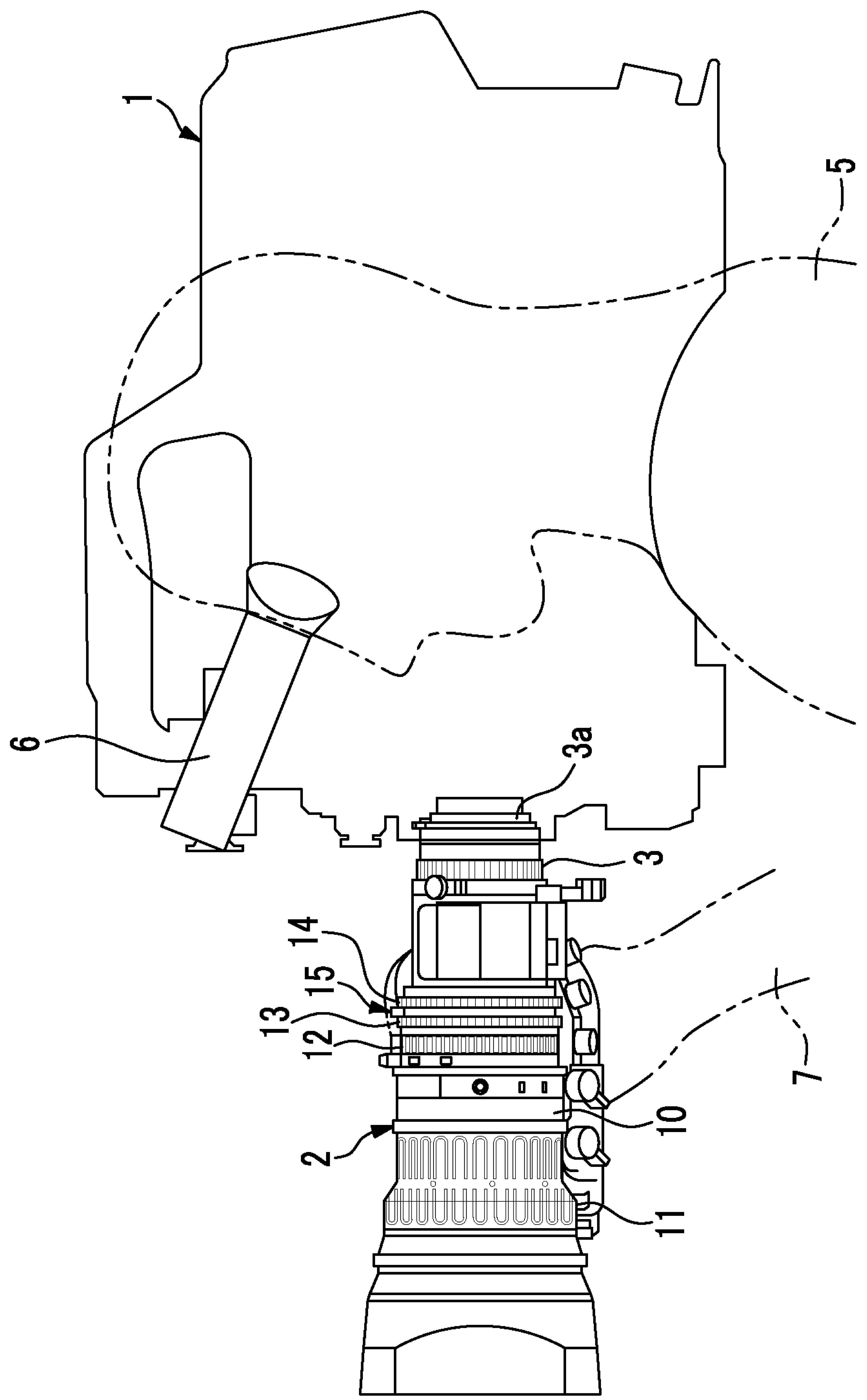


FIG. 2A

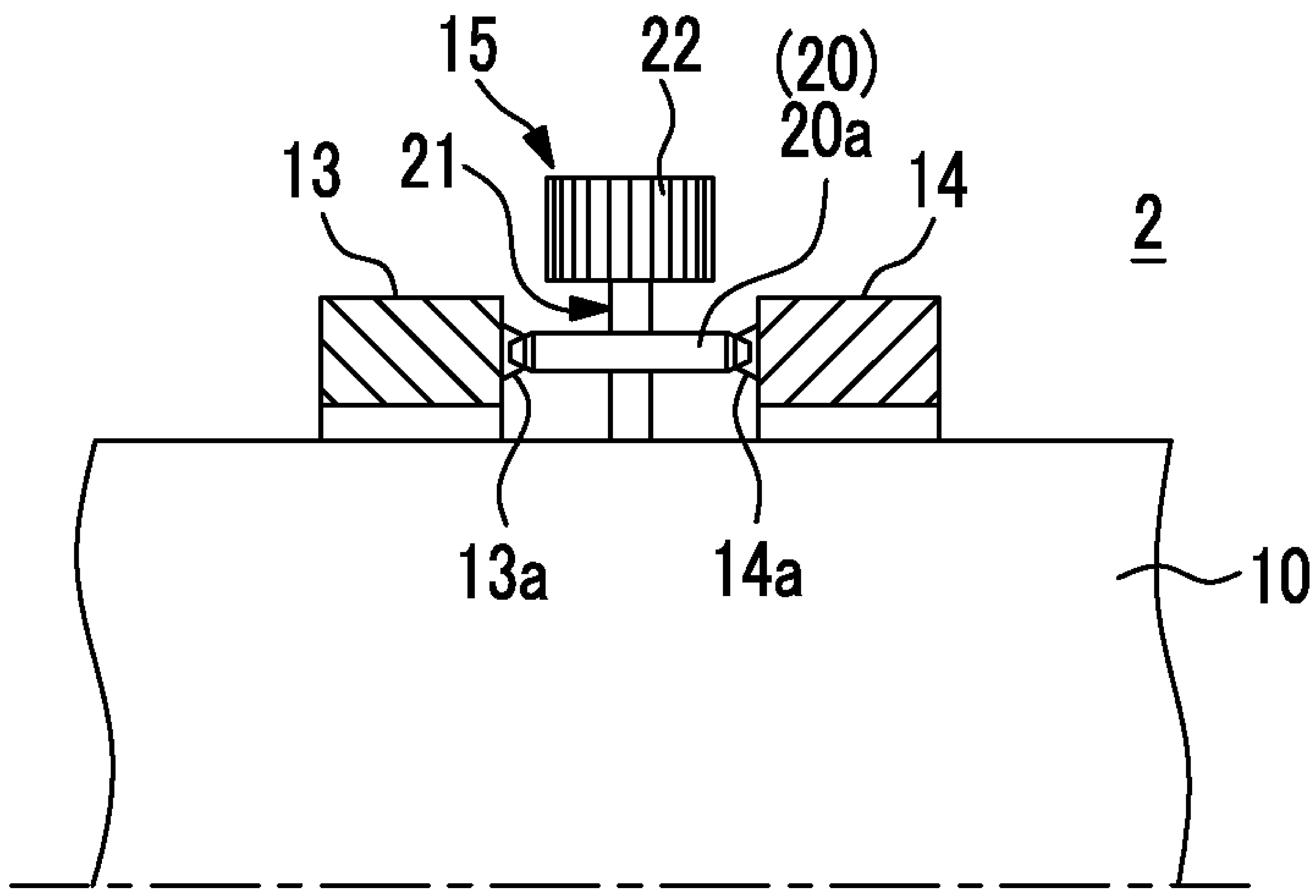


FIG. 2B

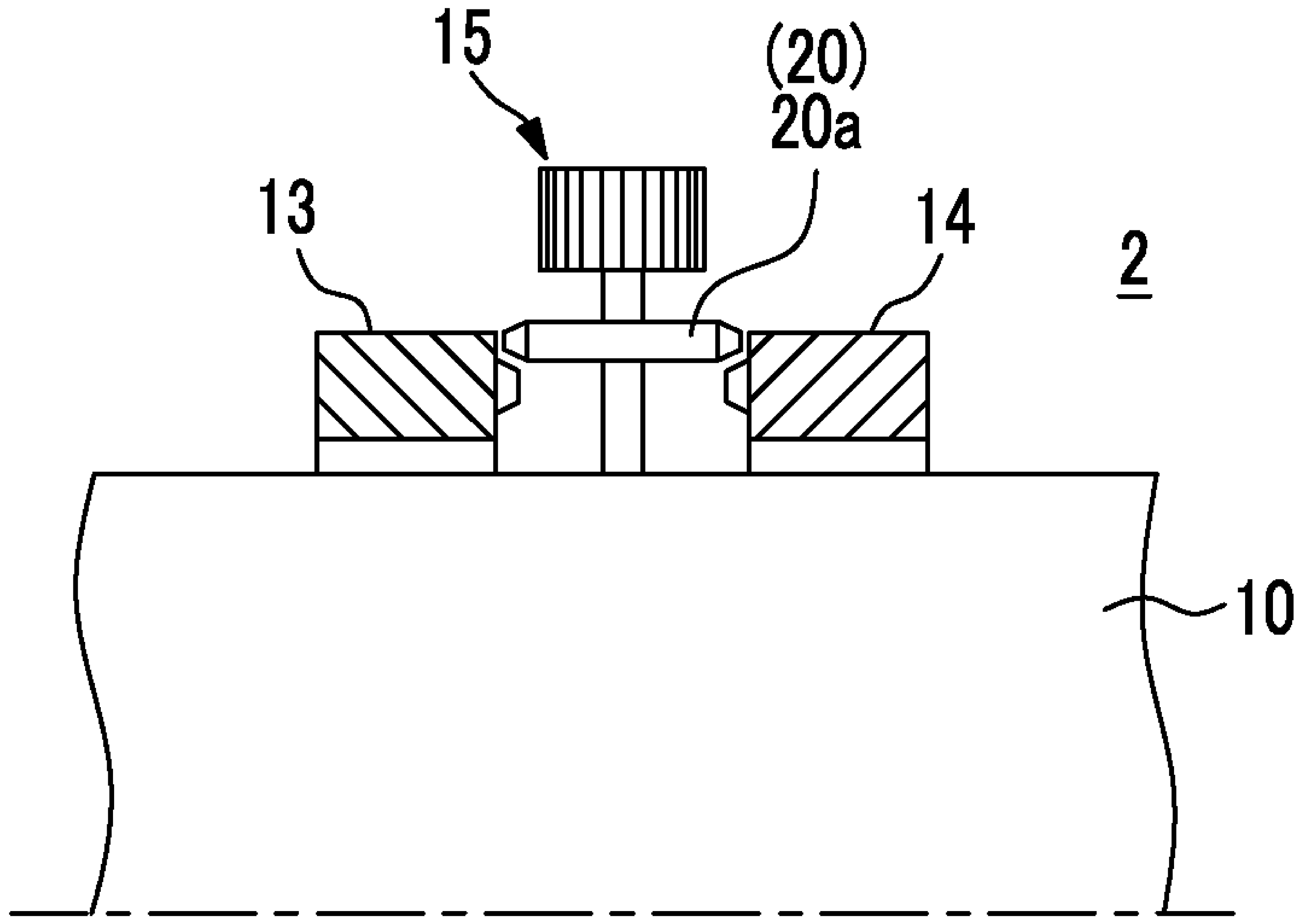


FIG. 3A

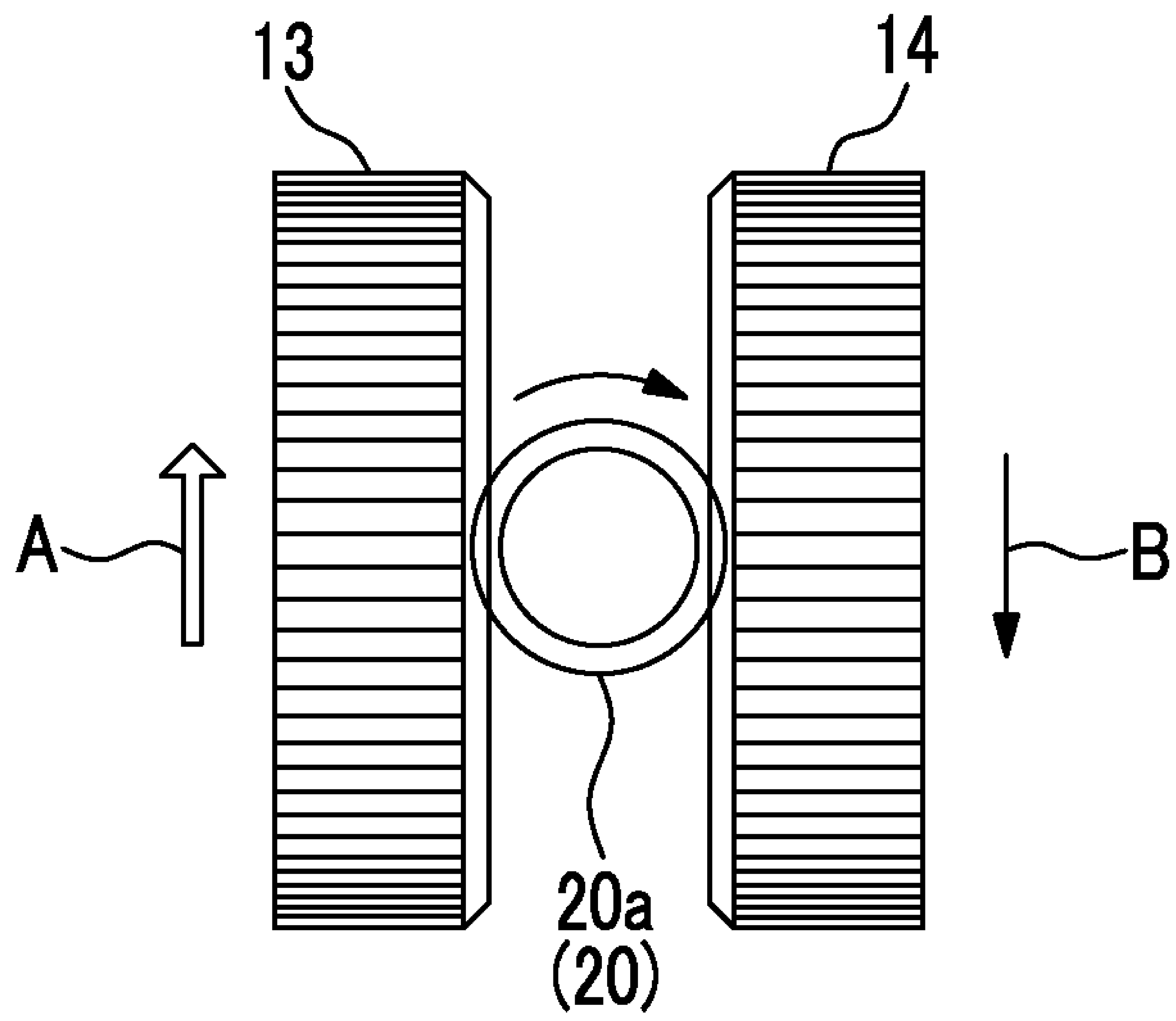


FIG. 3B

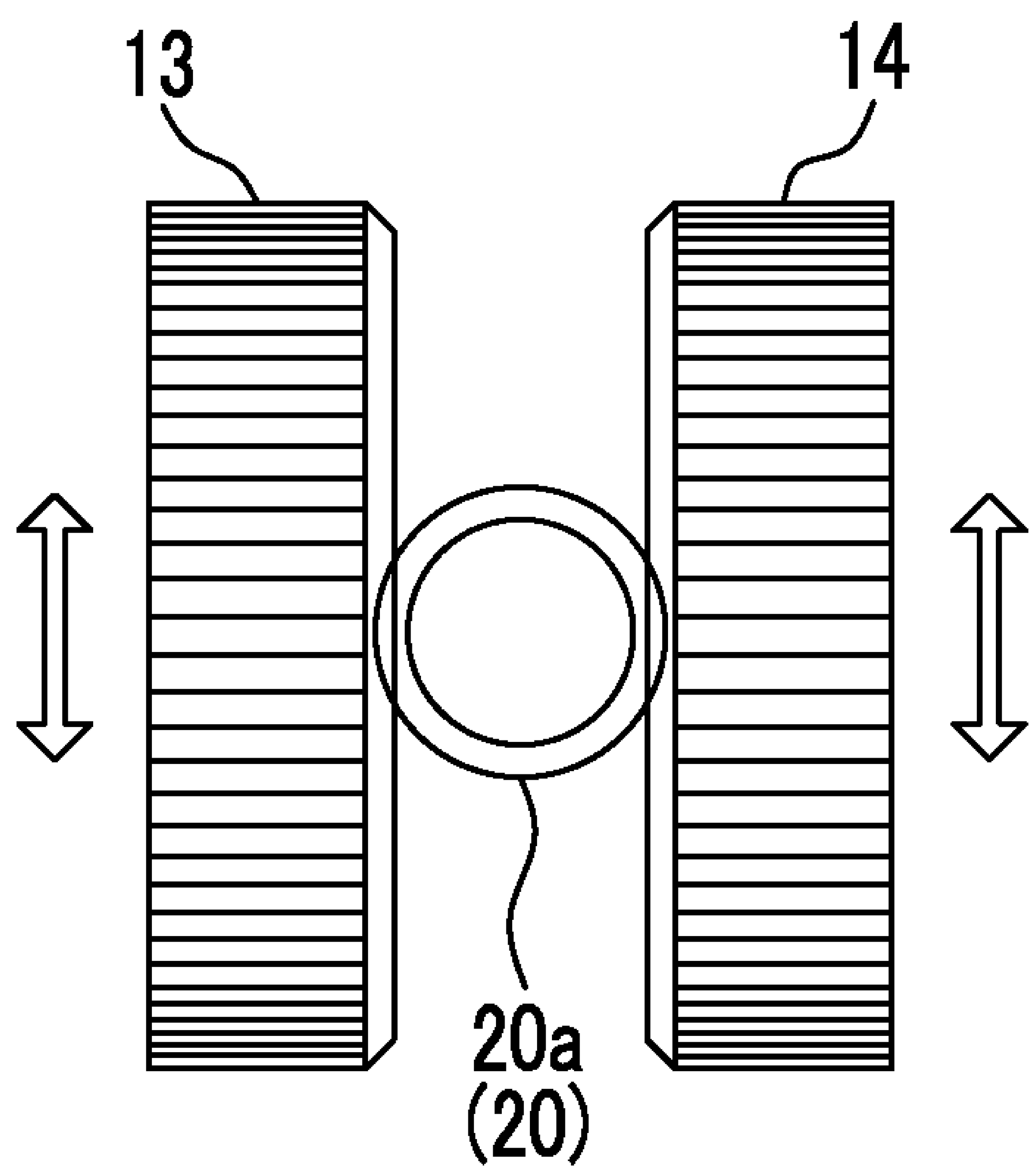


FIG. 4A

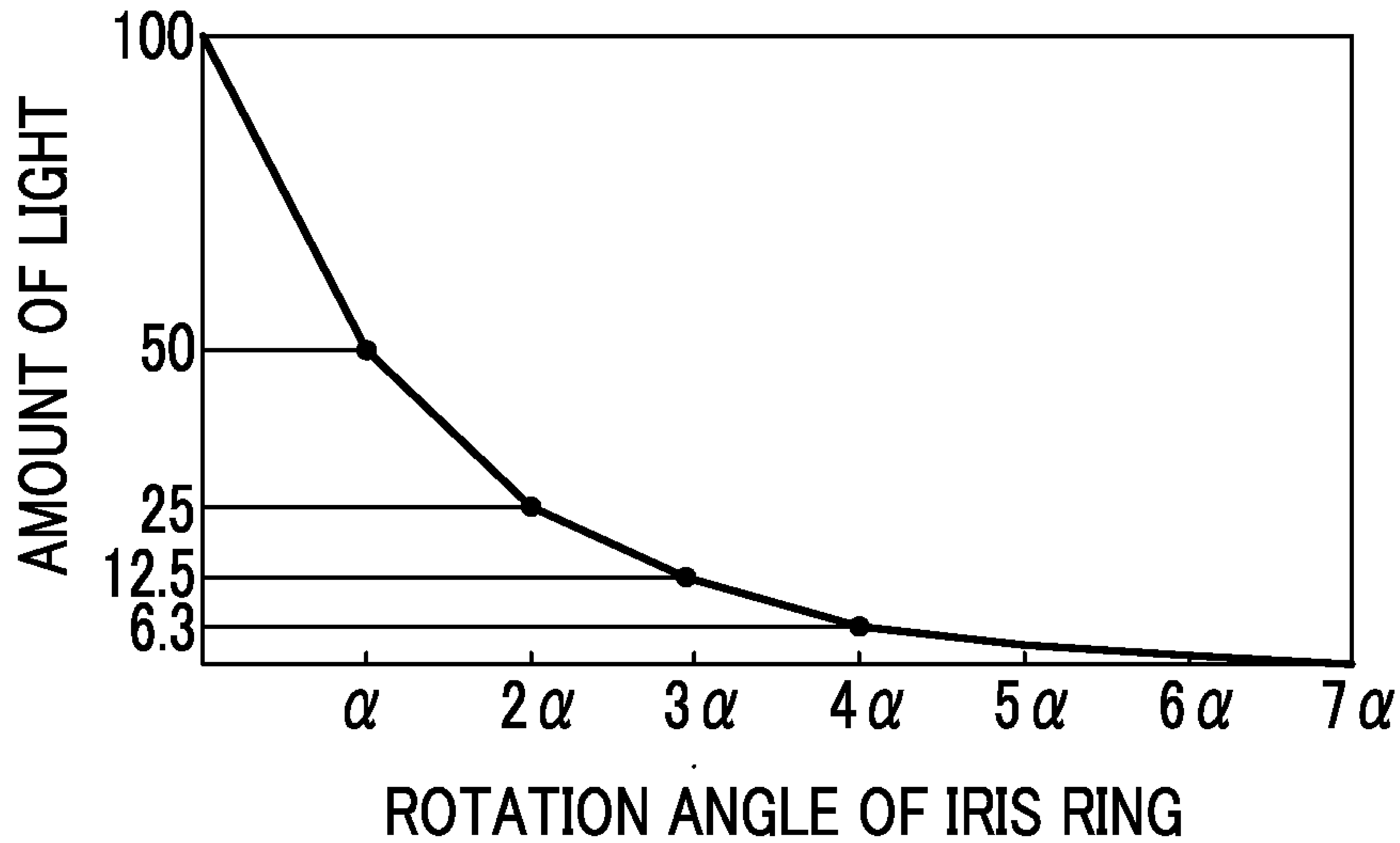

100
50
25
12.5
6.3
AMOUNT OF LIGHT
α
2α
3α
4α
5α
6α
7α
ROTATION ANGLE OF IRIS RING

FIG. 4B

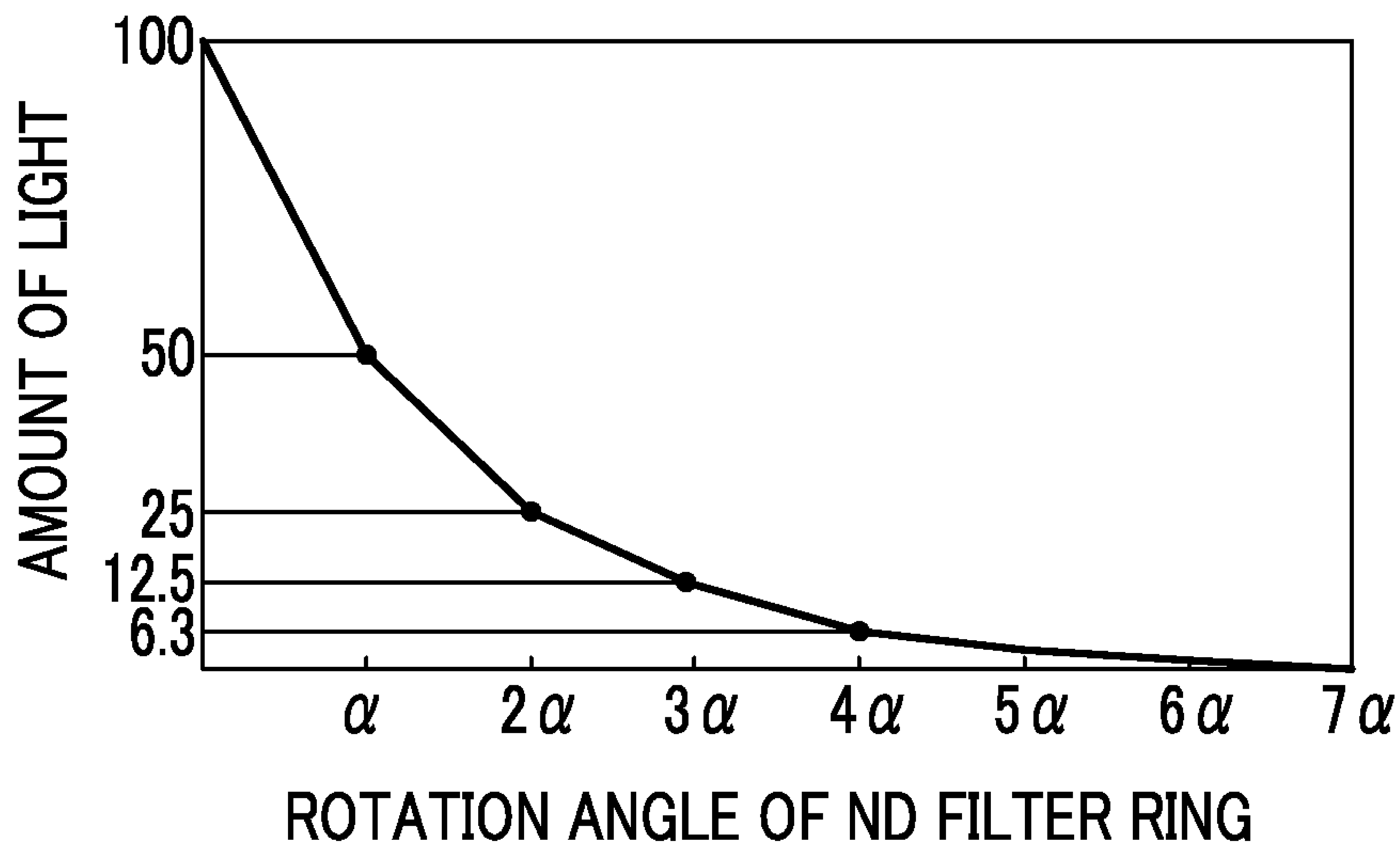

100
50
25
12.5
6.3
AMOUNT OF LIGHT
α
2α
3α
4α
5α
6α
7α
ROTATION ANGLE OF ND FILTER RING

FIG. 5A

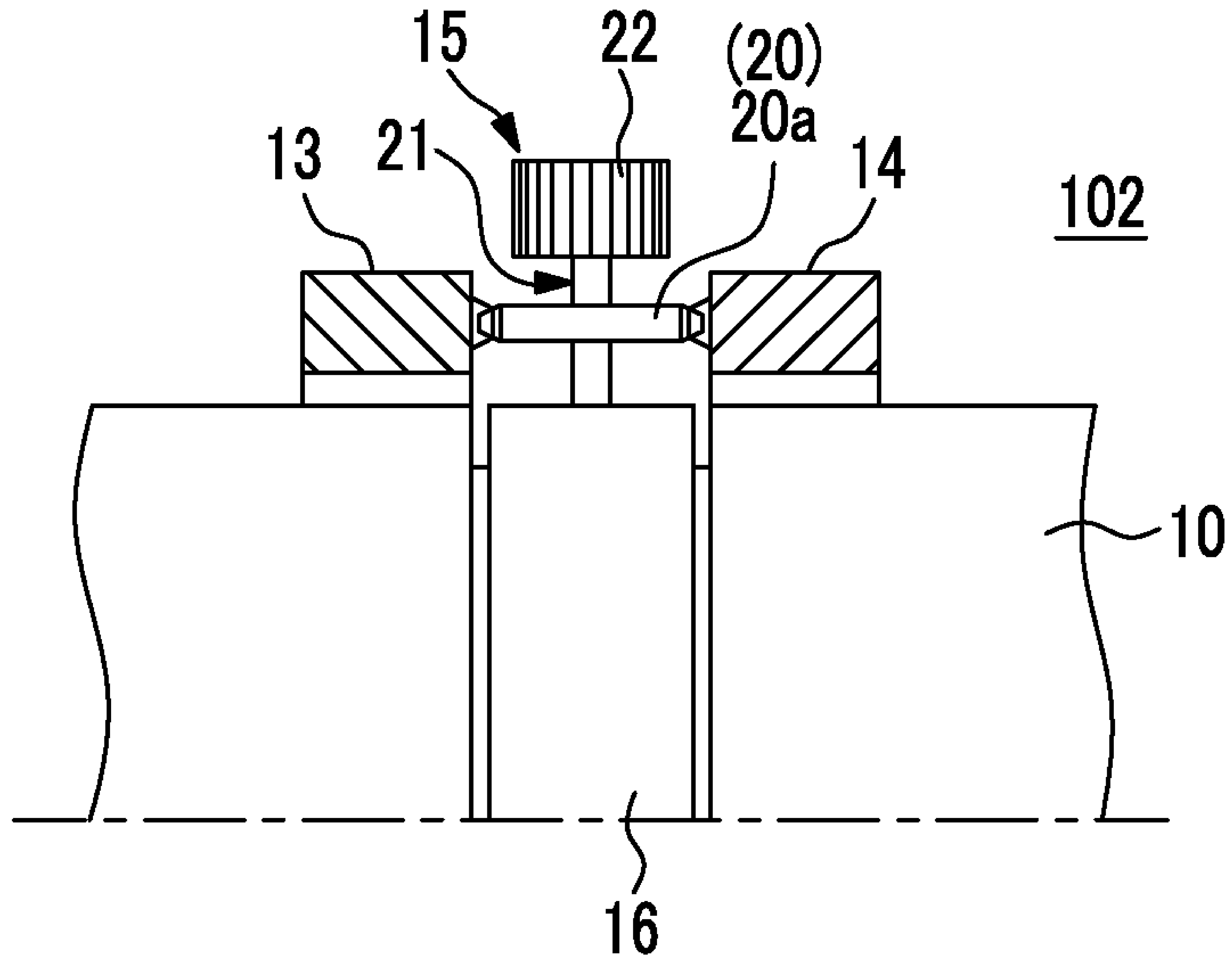


FIG. 5B

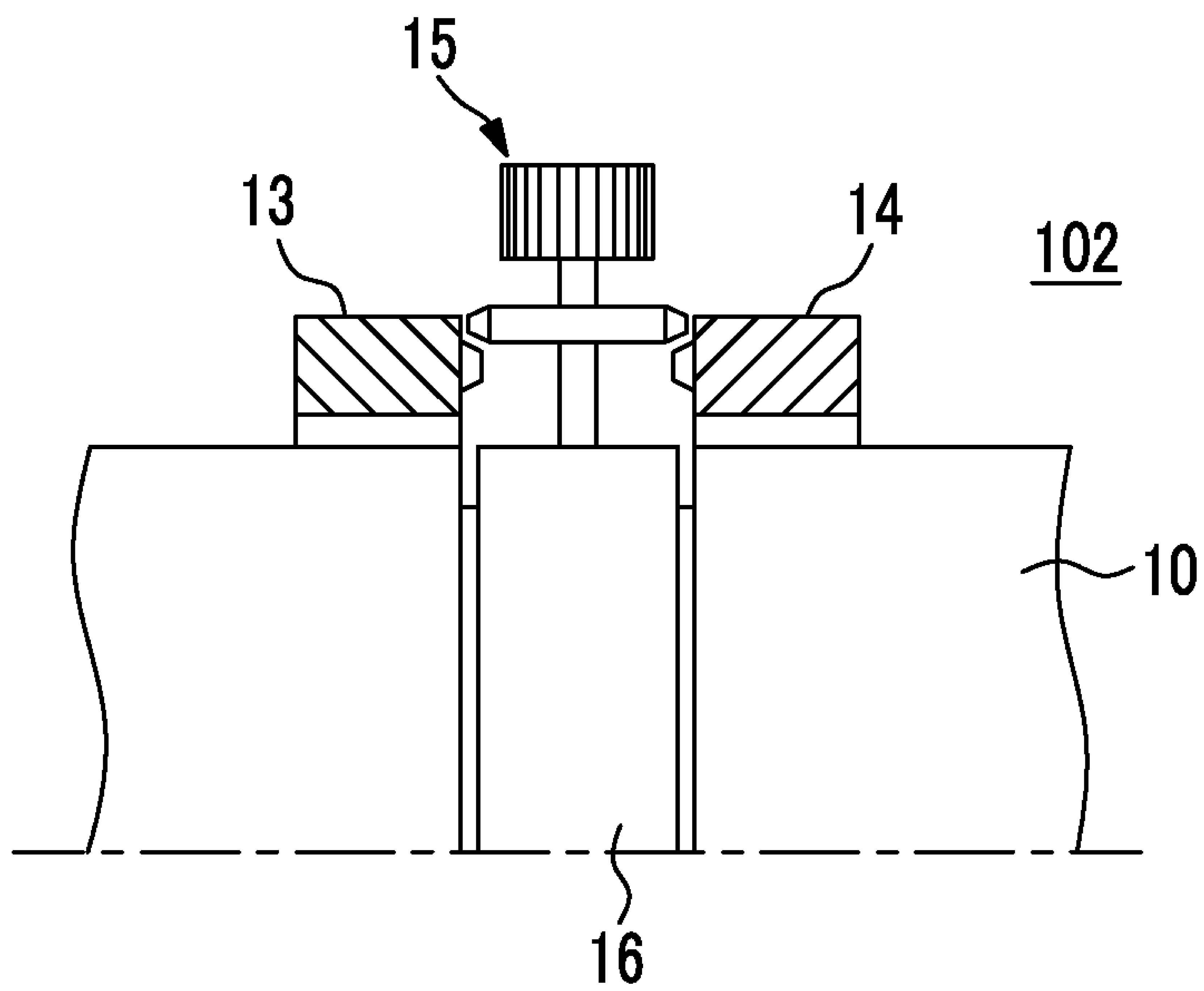


FIG. 6A

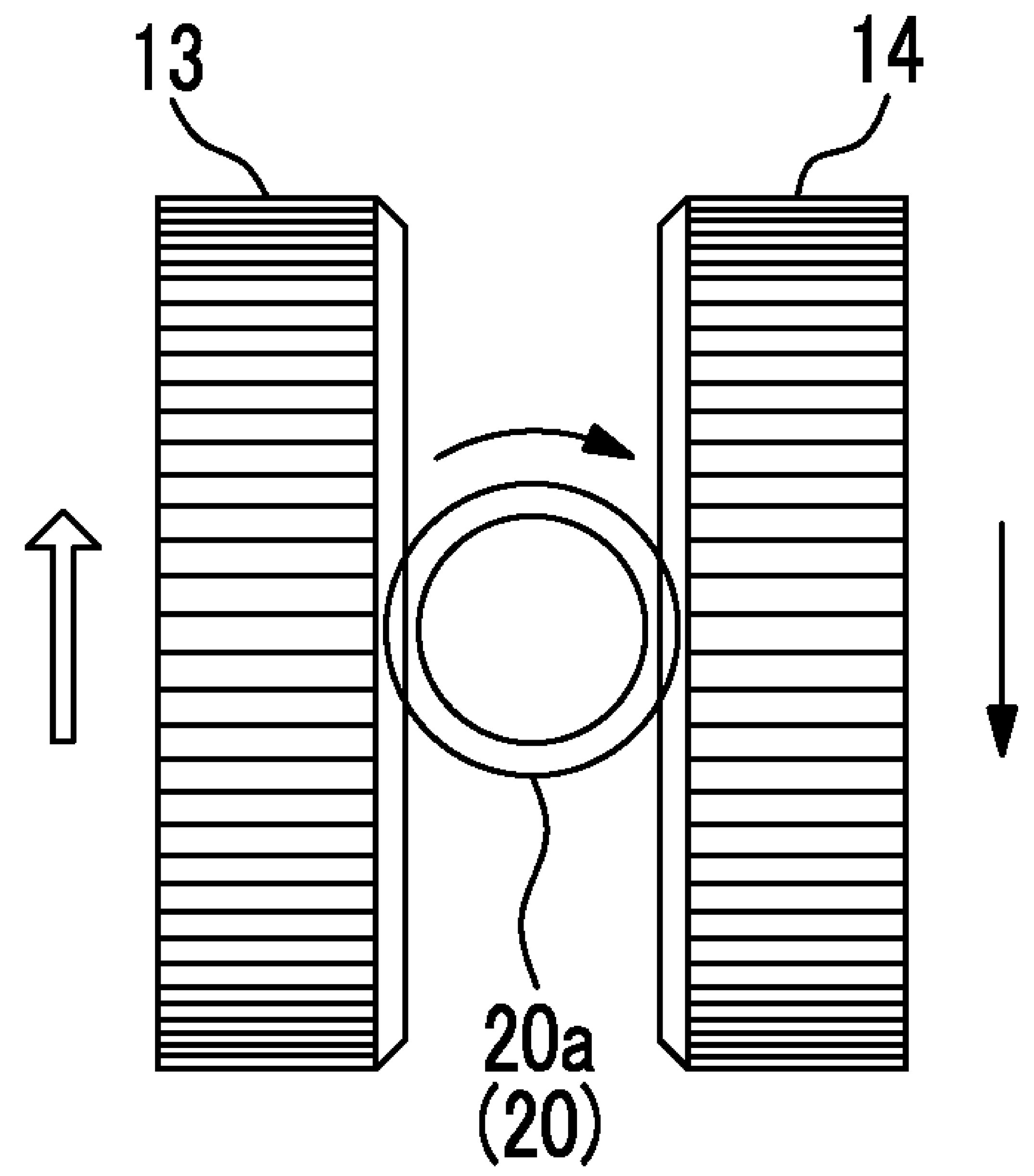


FIG. 6B

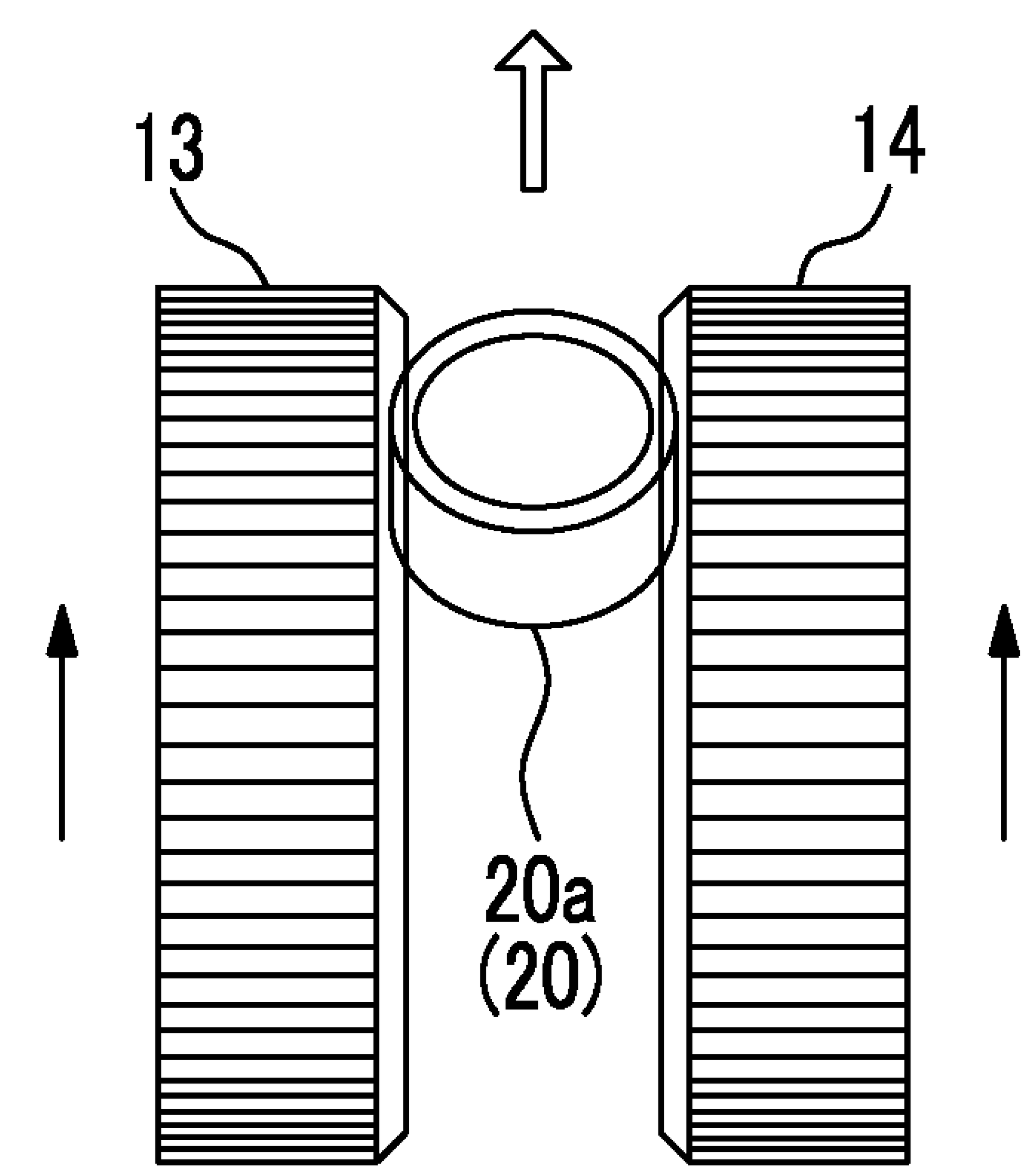


FIG. 7

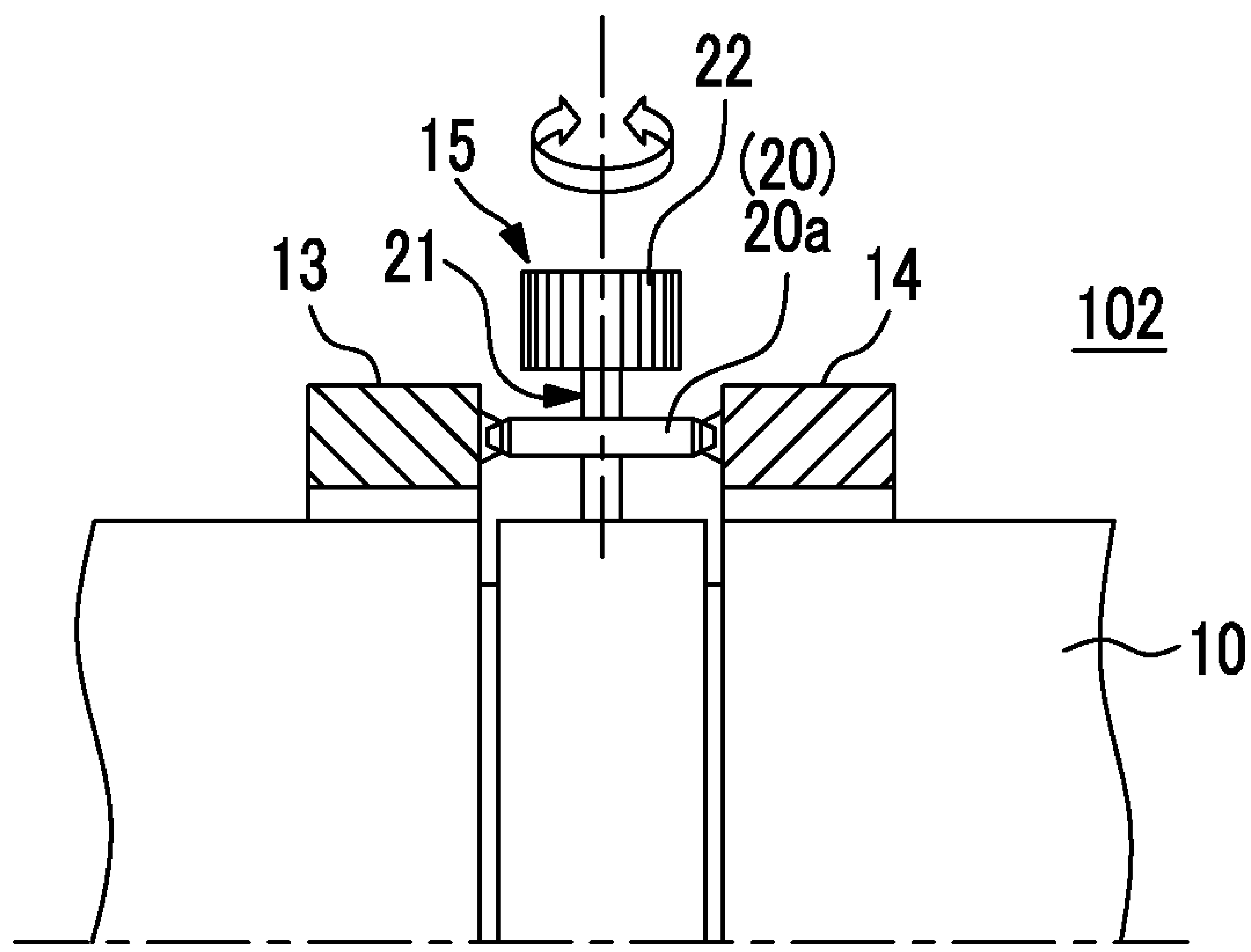


FIG. 8A

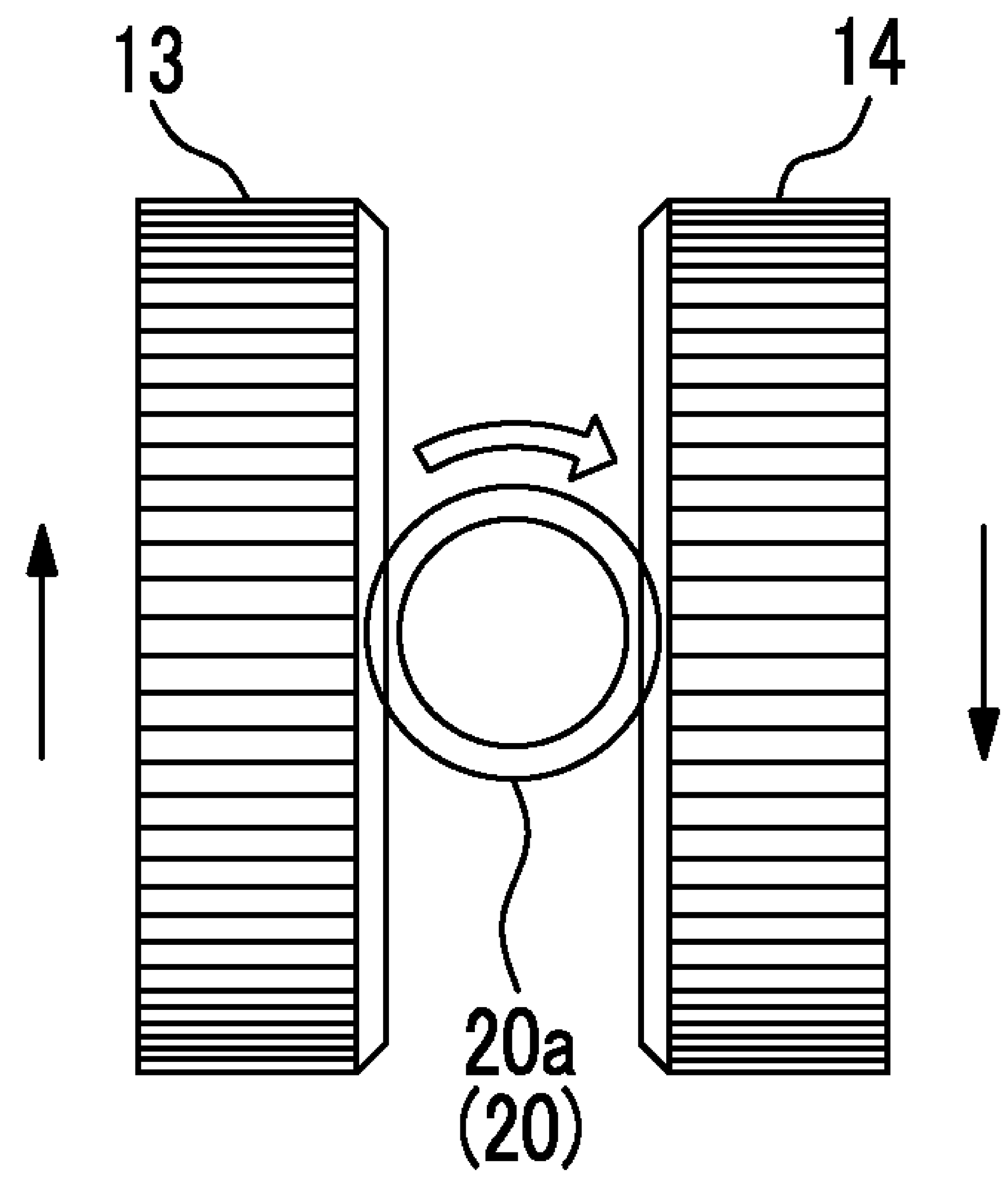


FIG. 8B

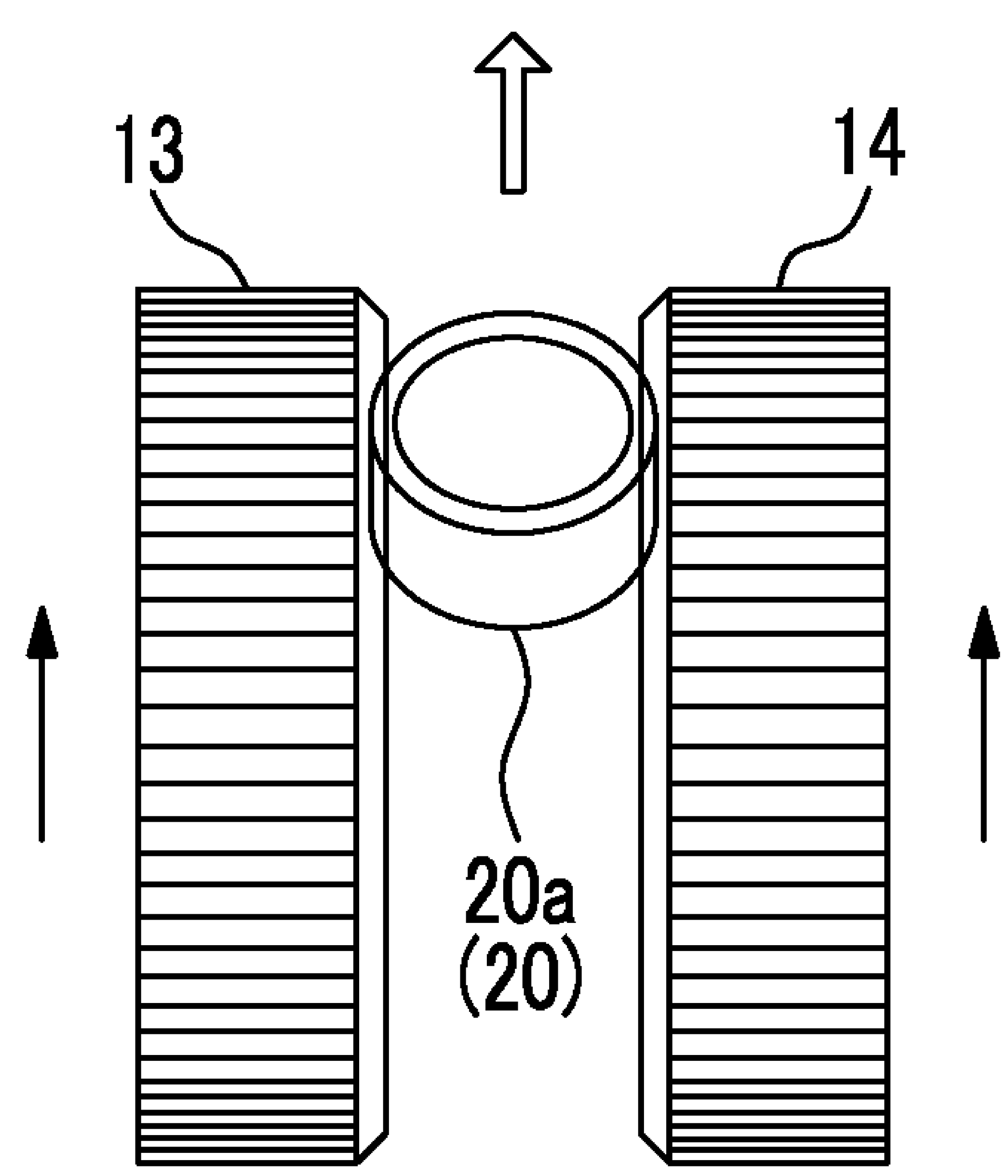


FIG. 9A

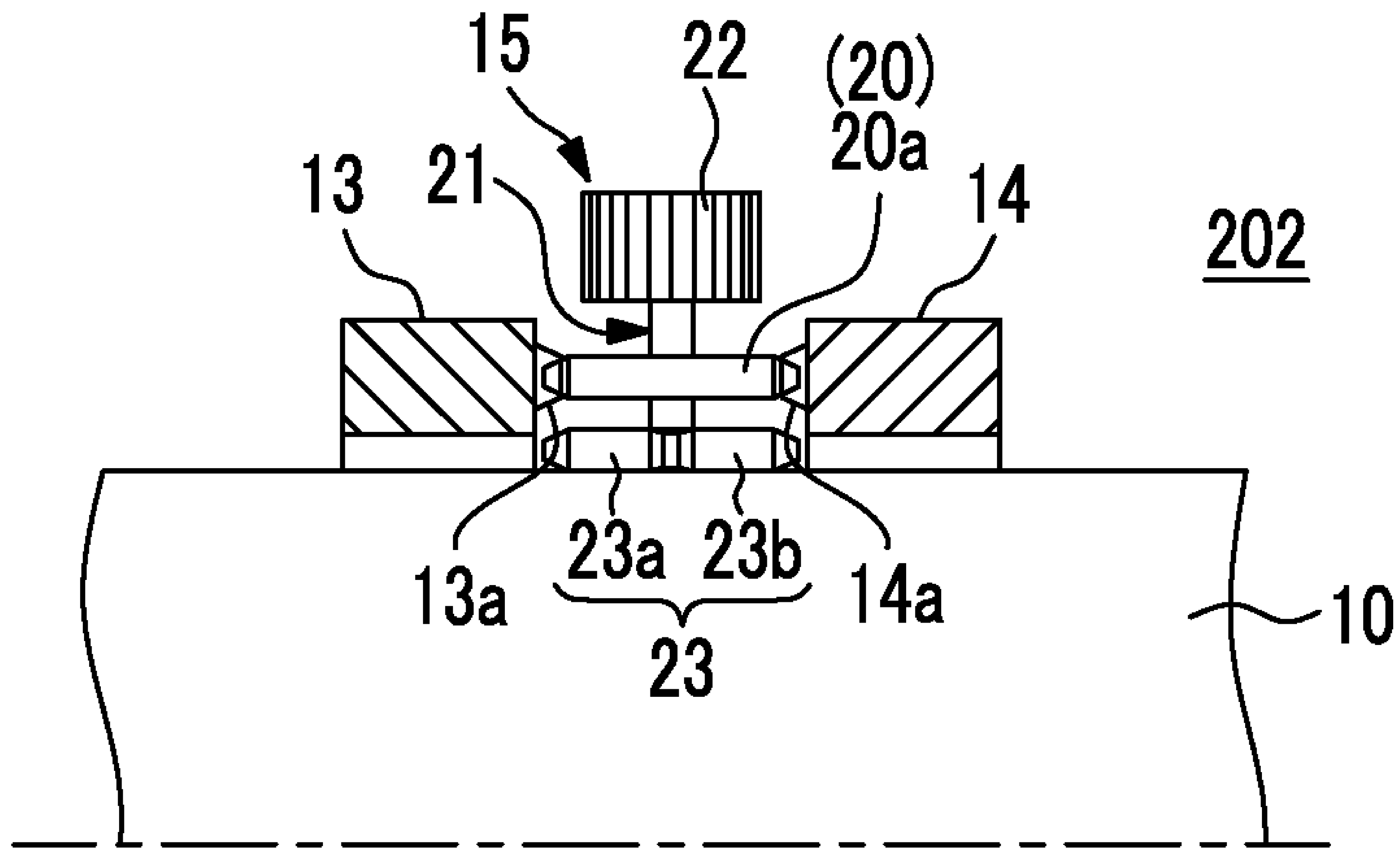


FIG. 9B

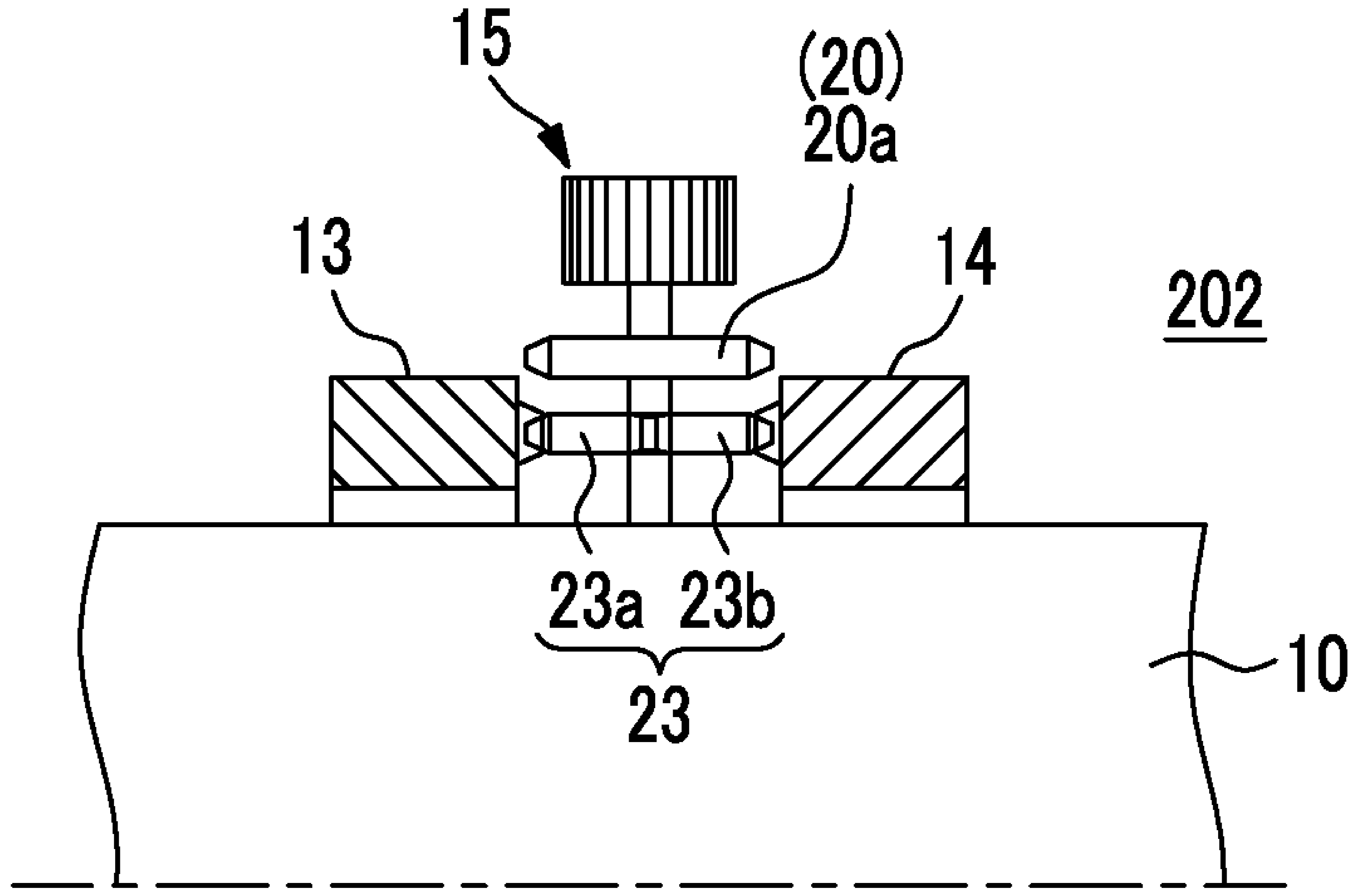


FIG. 9C

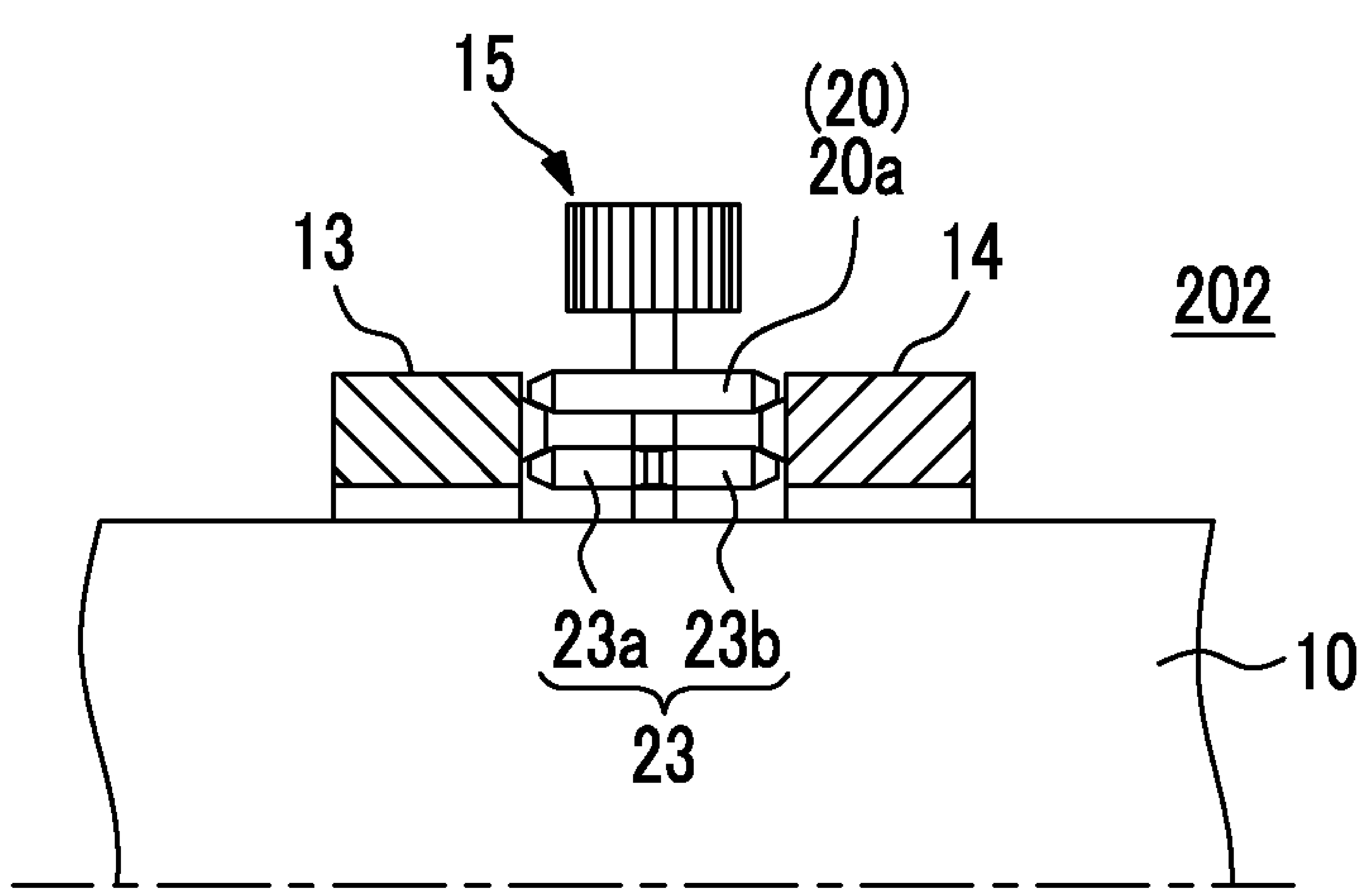


FIG. 10A

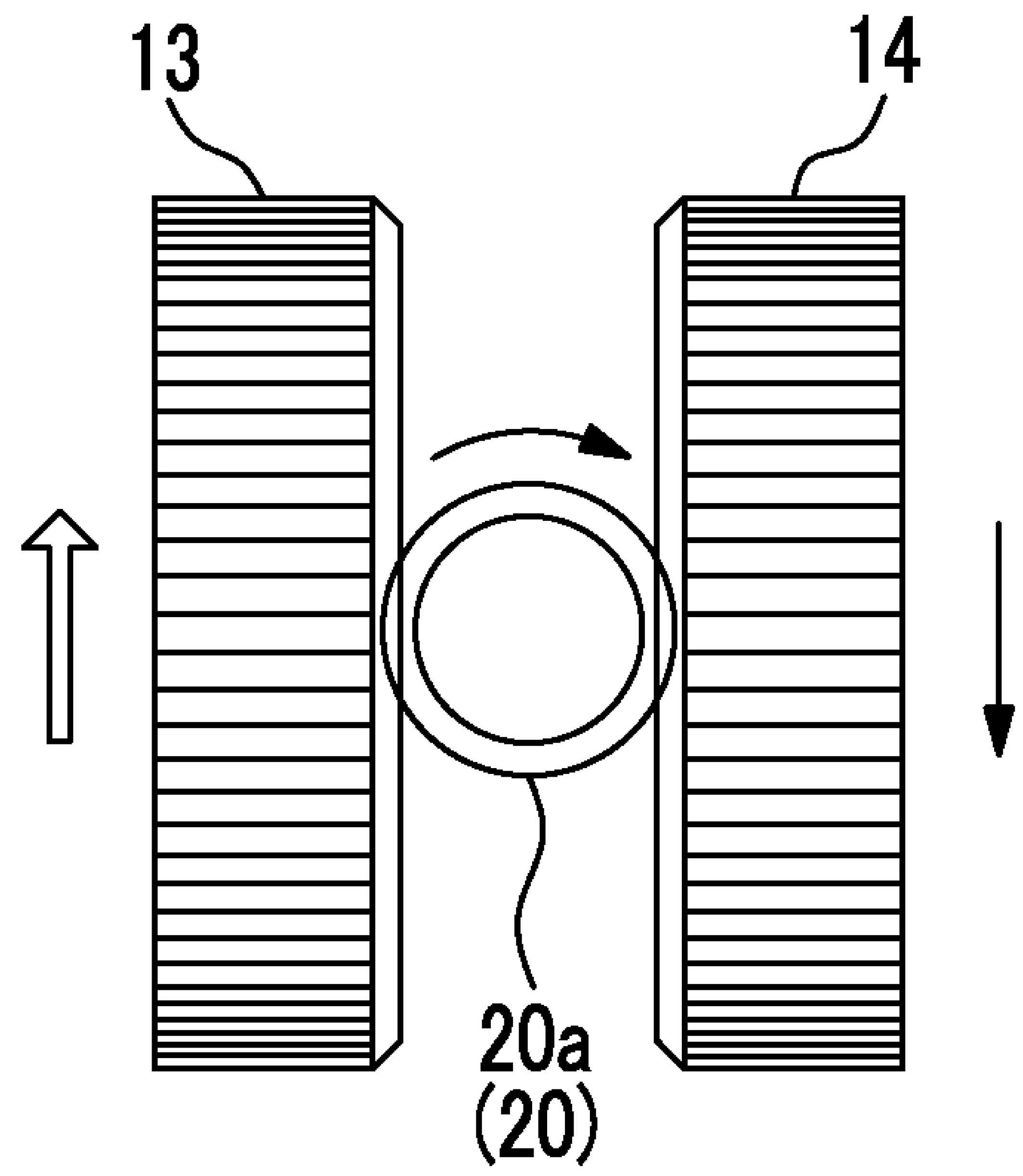


FIG. 10B

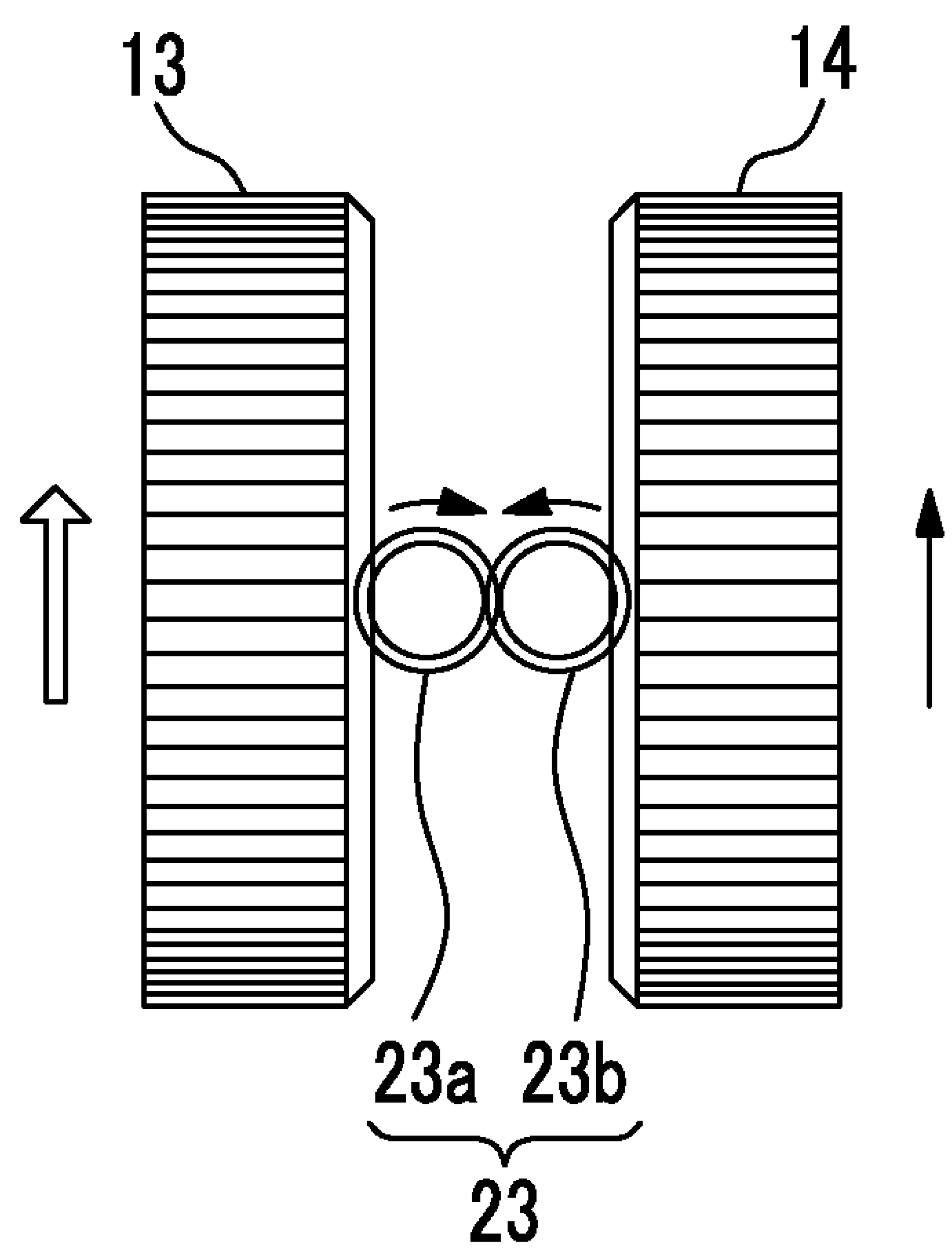


FIG. 11

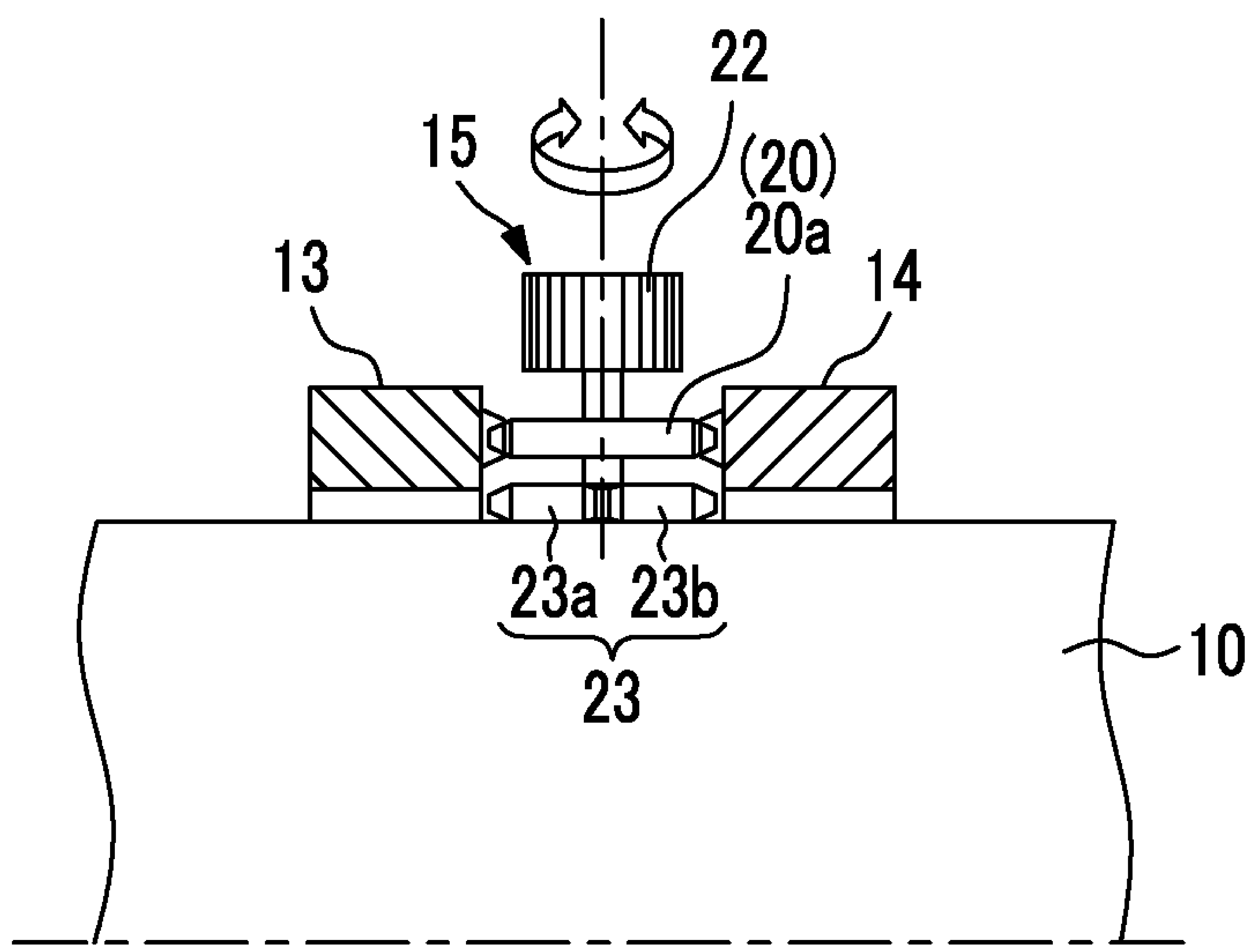


FIG. 12

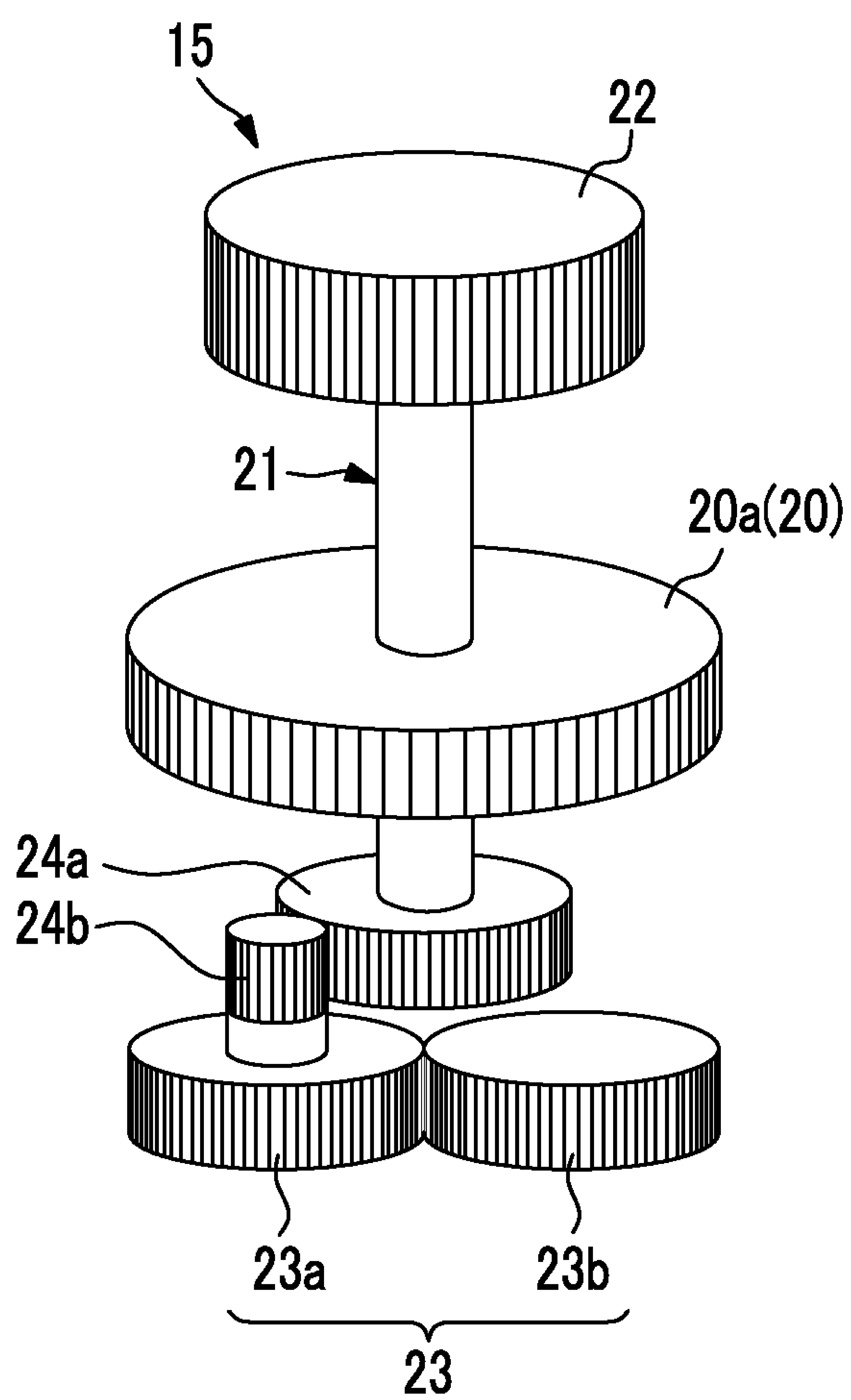


FIG. 13A

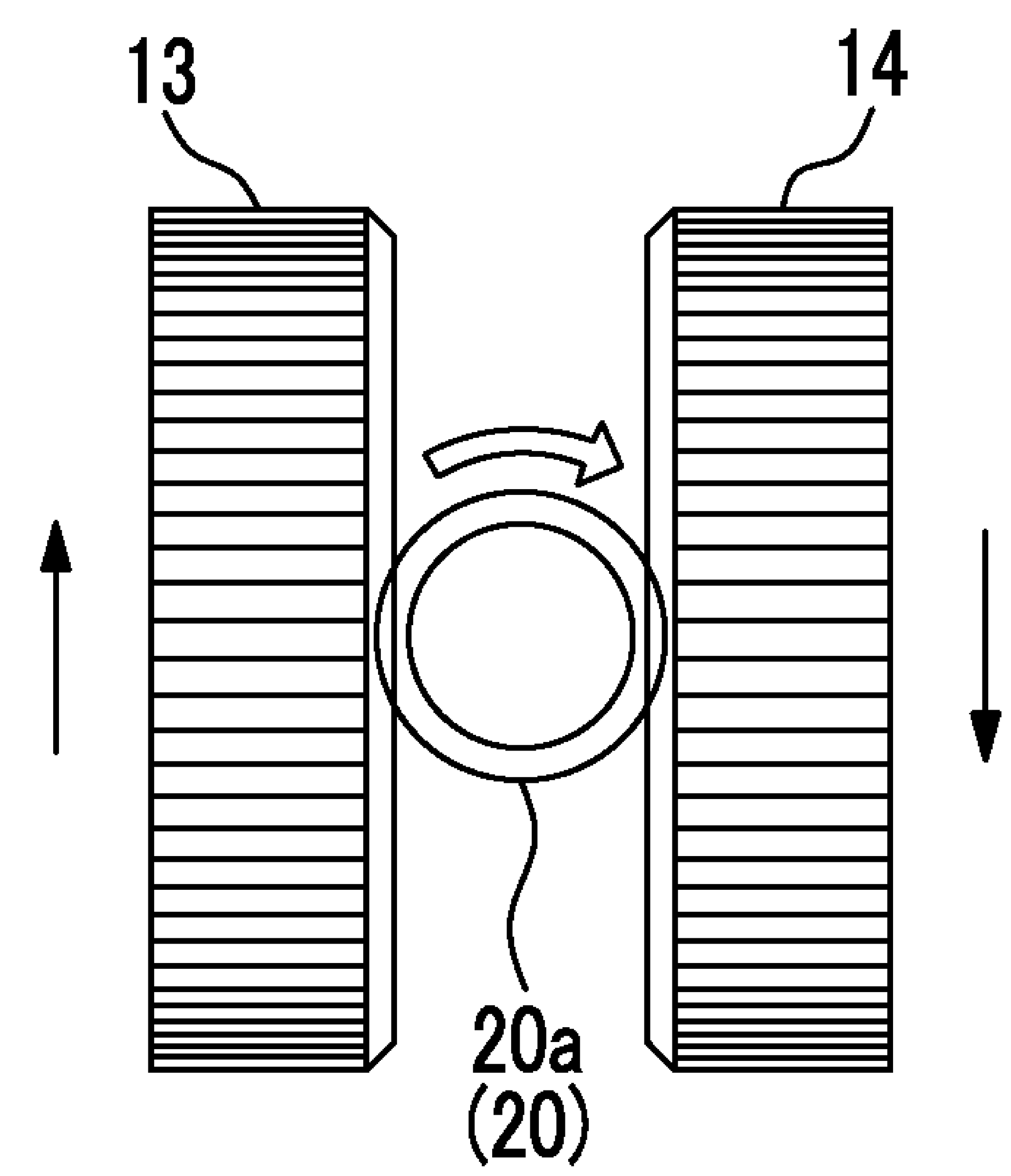


FIG. 13B

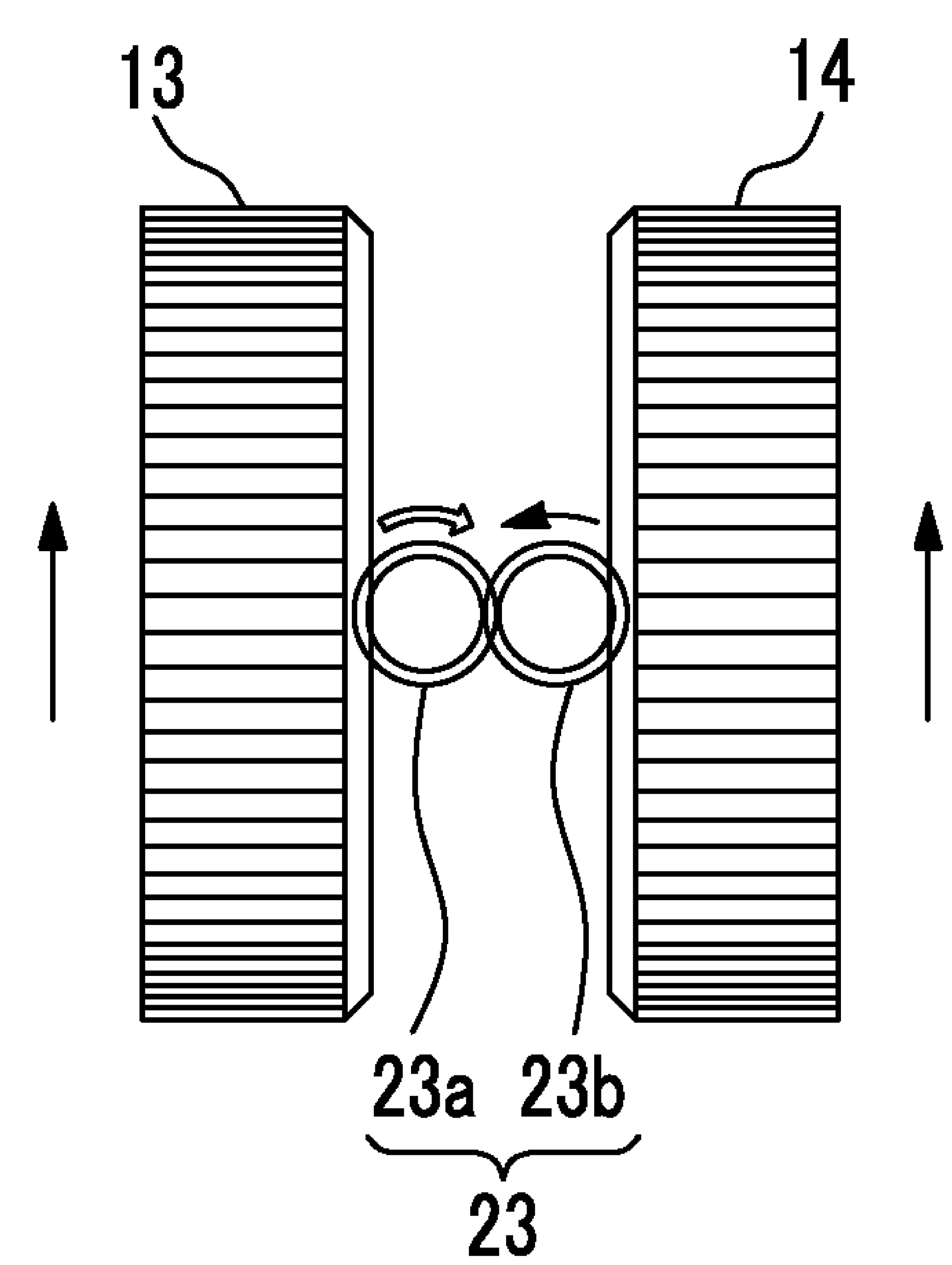
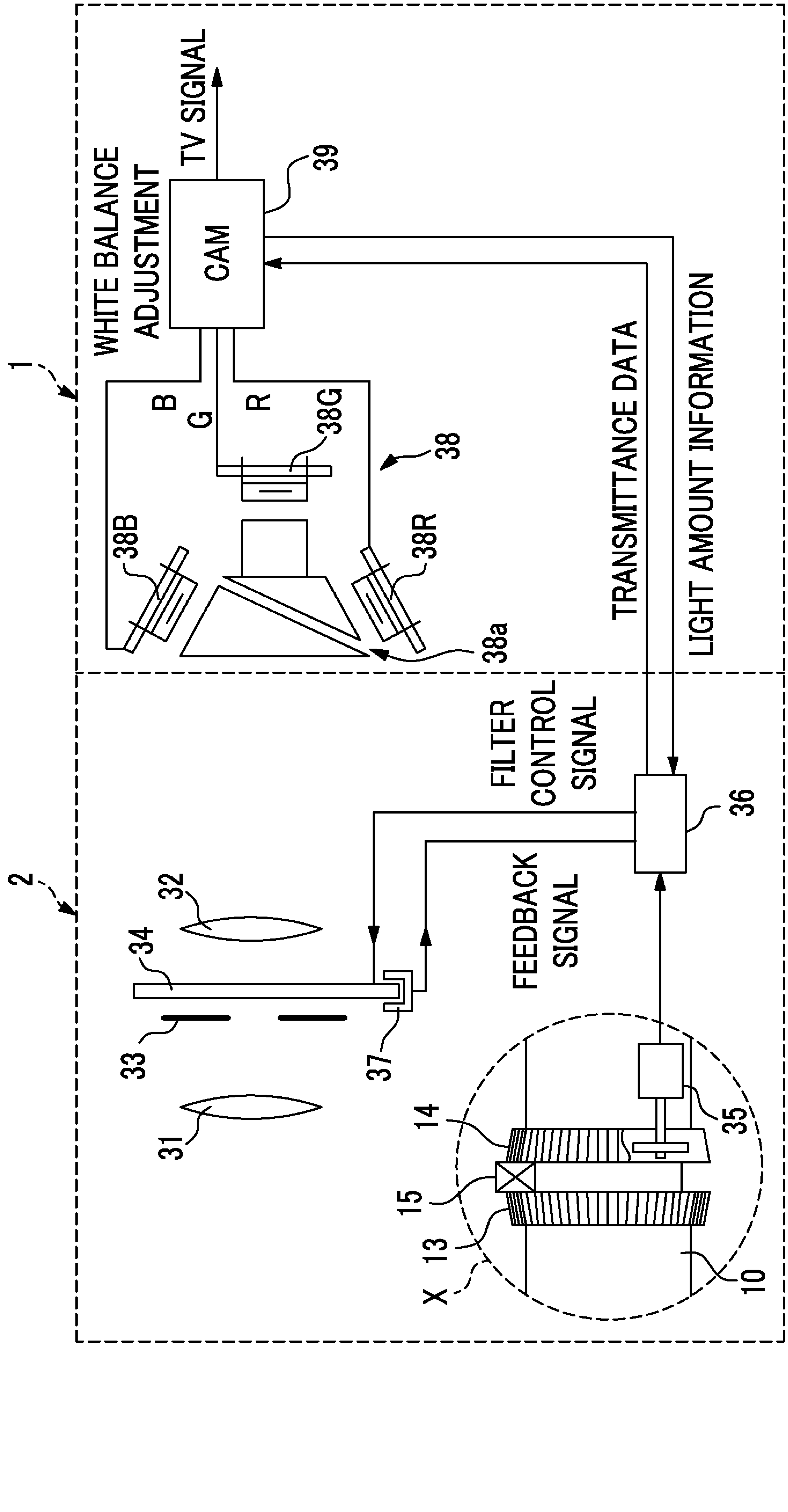


FIG. 14



WHITE BALANCE ADJUSTMENT
TV SIGNAL
CAM
39
B
G
R
38G
38
38B
38R
38a
TRANSMITTANCE DATA
LIGHT AMOUNT INFORMATION
FILTER CONTROL SIGNAL
FEEDBACK SIGNAL
36
1
2
32
34
33
37
31
14
15
13
X
35
10

FIG. 15

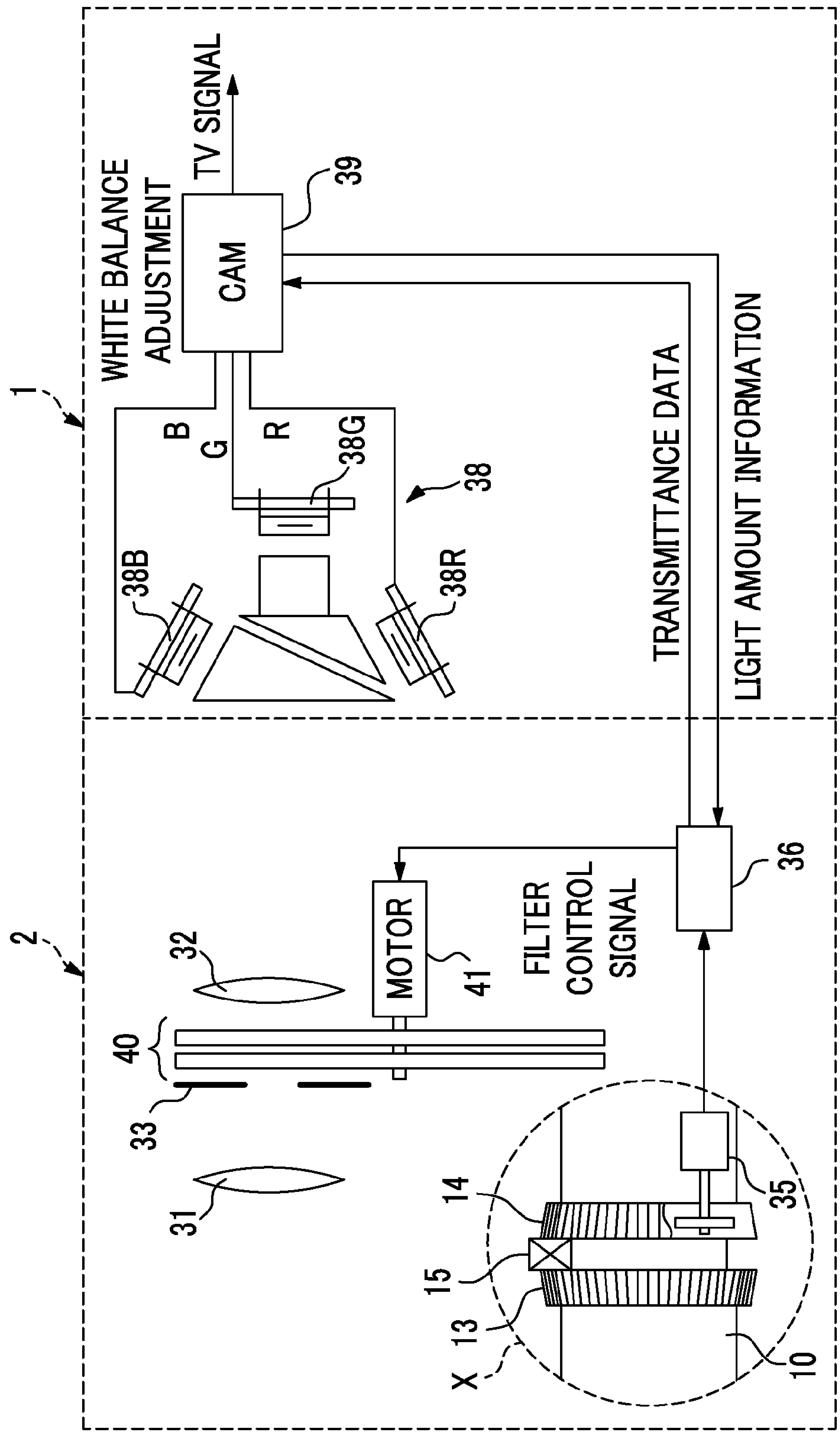

1
2
TV SIGNAL
WHITE BALANCE ADJUSTMENT
CAM
39
B
G
R
38G
38
38B
38R
TRANSMITTANCE DATA
LIGHT AMOUNT INFORMATION
32
MOTOR
41
FILTER CONTROL SIGNAL
36
40
33
31
14
15
13
X
35
10

FIG. 16

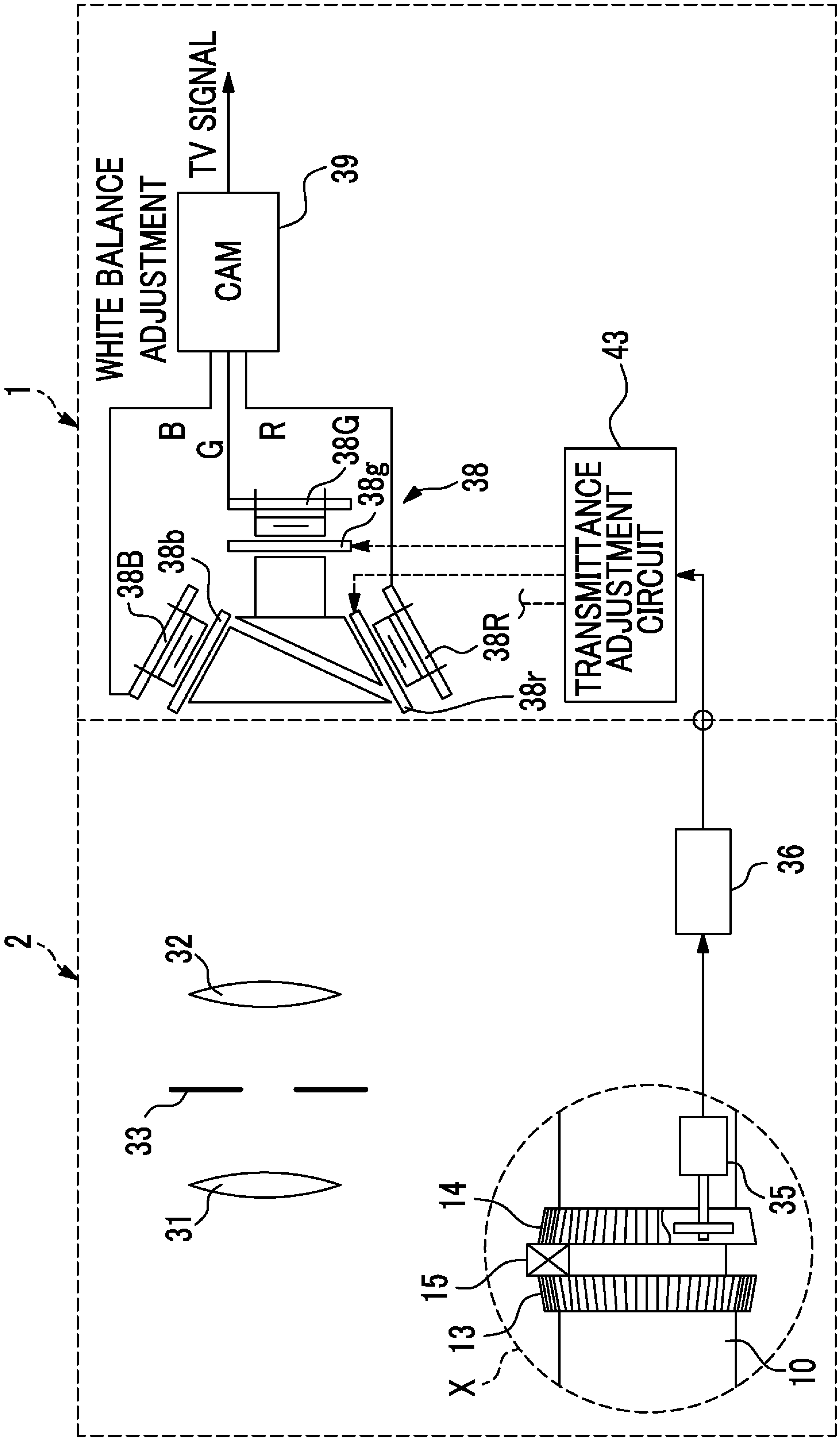
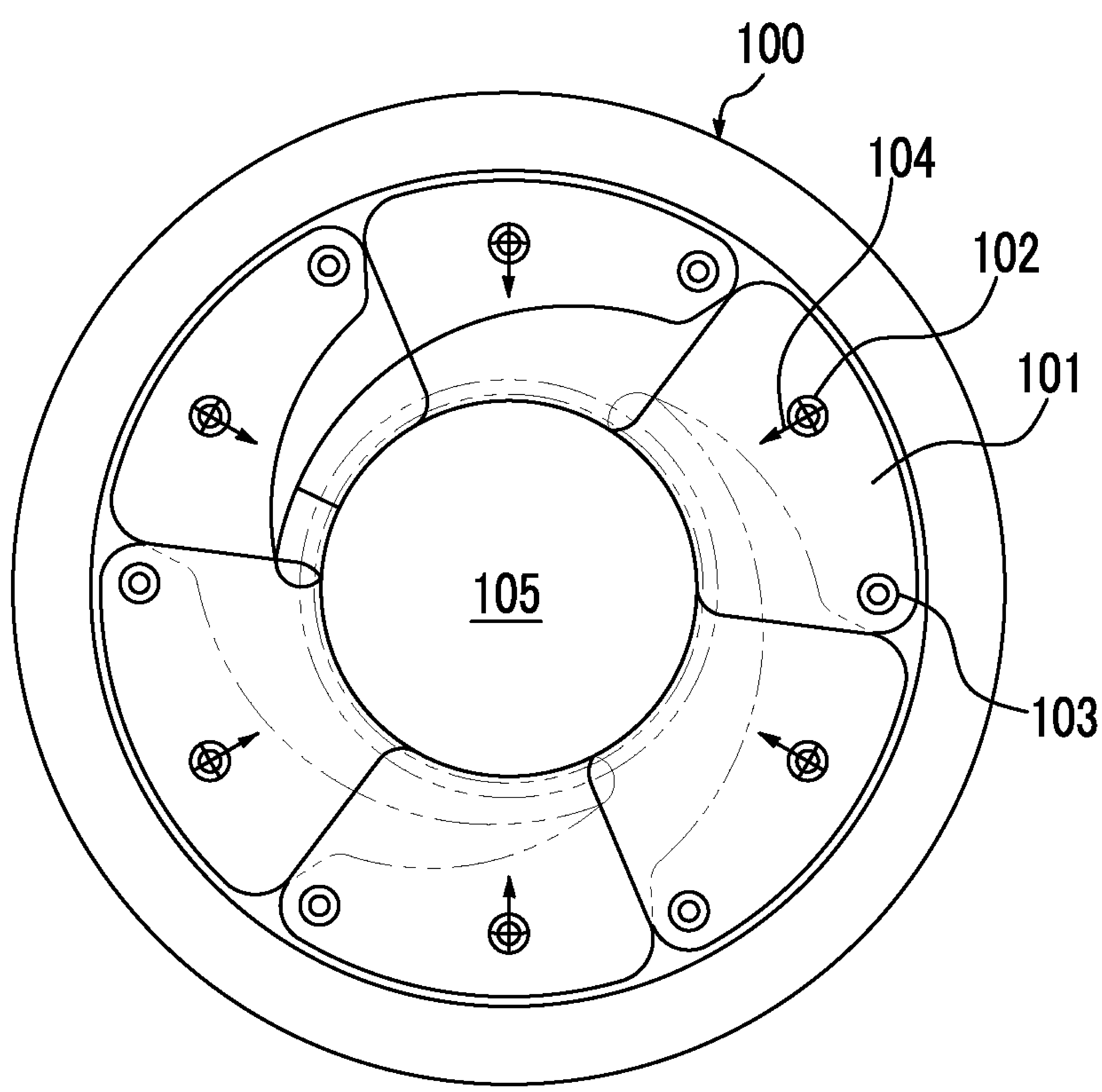

WHITE BALANCE ADJUSTMENT
TV SIGNAL
CAM
39
1
B
G
R
38G
38g
38
38B
38b
38R
38r
43
TRANSMITTANCE ADJUSTMENT CIRCUIT
2
32
33
31
36
14
15
13
X
35
10

FIG. 17



PRIOR ART

LENS DEVICE AND IMAGING DEVICE MOUNTED WITH THE LENS DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation of PCT International Application No. PCT/JP2012/074723 filed on Sep. 9, 2012, which claims priority under 35 U.S.C. §119(a) to Patent Application No. 2011-218530 filed in Japan on Sep. 30, 2011, all of which are hereby expressly incorporated by reference into the present application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a lens device mounted on a video camera or a television camera. In particular, the present invention relates to a lens device, which has both of an operation tool that manually operates an aperture stop device so as to adjust an amount of incident light and an operation tool that manually adjusts an amount of transmitted light of a variable light transmission filter, and an imaging device mounted with the lens device.

2. Description of the Related Art

As the device that adjusts the amount of incident light, an aperture stop (iris) device is generally used. For example, an aperture stop device **100** shown in FIG. **17** is configured such that a plurality of (six, in the example shown in the drawing) aperture stop blades **101**, which functions as an iris, is disposed on a circumference and a driving point **102** of each blade **101** is moved in a direction of an arrow **104** centered on a supporting point **103** so as to decrease an aperture area (aperture size) of a center hole **105** which transmits incident light.

In the aperture stop device **100**, when the amount of incident light is intended to be decreased, the center hole **105** is narrowed. However, when a bright outdoor image is photographed at a minimum aperture position, blurring which is caused by a decrease in a resolving power decreased by the effect of the diffraction phenomenon, so-called small aperture blurring may occur, and may deteriorate a quality of a photographed image.

For this reason, as the device that adjusts the amount of incident light, for example, an ND filter disclosed in JP2007-243928A to be described later has been proposed. The ND filter is formed as a discoid filter in which a density of a dimming material continuously changes along the circumference. In addition, by adjusting the rotation position of the discoid filter, the amount of transmitted light of the filter is controlled.

Further, a light amount adjustment device disclosed in JP2006-126504A has been proposed. In the light amount adjustment device, electrodes are provided on both surfaces of a discoid dielectric elastomer placed on the optical path, a voltage applied between the electrodes is adjusted, and a thickness of the discoid film is controlled, thereby realizing the ND filter of which the amount of transmitted light is variable.

By inserting the variable light transmission filter exemplified in JP2007-243928A and JP2006-126504A into the aperture stop device shown in for example FIG. **17**, it is possible to avoid occurrence of small aperture blurring even when photographing the bright outdoor image. However, in the variable light transmission filter, it is difficult to perform imaging that blurs the background through adjustment of the

depth of field performed by adjusting the aperture stop diameter, the adjustment being regarded as an advantage of the aperture stop device.

That is, both the aperture stop device and the variable light transmission filter are able to adjust the amount of incident light, but both have advantages and disadvantages for other functions.

For this reason, as disclosed in the following JP-H09-186922A and JP-H05-292392A, imaging devices, which use both the aperture stop device and the variable light transmission filter (variable ND filter) in combination, have been proposed. In such imaging devices, it is possible to perform appropriate exposure in any imaging condition, it is also possible to avoid small aperture blurring, and it is also possible to adjust the depth of field. However, since costs increase in order to mount two light amount adjustment means, it is difficult to apply the above-mentioned configuration to an actual device.

SUMMARY OF THE INVENTION

In recent years, considerable progress has been made in reduction in manufacturing costs and enhancement in performance of the variable light transmission filter, and thus it is possible to mount both the aperture stop device and the variable light transmission filter on an actual imaging device.

However, in the lens device mounted on the imaging device, there are multiple adjustment tools (operation tools), such as a magnification adjustment ring and a focus position adjustment ring of the zoom lens, which a photographer operates with only the sense of touch of the hand while viewing a finder device. Hence, when the adjustment tool of the aperture stop device and the adjustment tool of the variable light transmission filter are mounted on the actual device, it is necessary to consider which specific mount form is better to provide a lens device excellent in usability.

An object of the present invention is to provide a lens device, which is capable of performing various kinds of image capturing appropriate for an intention of a photographer by using the variable light transmission filter and the aperture stop device having in common a function of adjusting the amount of transmitted light and which is excellent in usability, and an imaging device mounted with the lens device.

(1) A lens device for an imaging device having a imaging-lens and an aperture stop device that adjusts an aperture area, the lens device including: a lens barrel that houses the imaging-lens and the aperture stop device; a first operation ring that is provided on an outer circumferential portion of the lens barrel at a desired position and is provided to be rotatable in a circumferential direction of the outer circumferential portion about an axis line of the lens barrel as a rotation axis in order to adjust the aperture area of the aperture stop device; a second operation ring that is provided in parallel with the first operation ring and provided to be rotatable in the circumferential direction of the outer circumferential portion about the axis line of the lens barrel as the rotation axis in order to adjust a transmittance of a variable light transmission filter; and a mechanism section that transfers rotations of the first operation ring and the second operation ring to each other and blocks the rotations. A rotation direction, in which the aperture area of the aperture stop device is increased by the first operation ring, is the same as a rotation direction in which the transmittance of the variable light transmission filter is increased by the second operation ring. The mechanism section is configured to be able to convert the rotations of the first operation ring and the second operation ring into rotations in

directions the same as each other or directions opposite to each other and transfer the rotations.

(2) An imaging device including the lens device of (1).

According to the present invention, a photographer, who photographs a moving image of an object with a television camera or a video camera, is able to perform various kinds of exposure control through combination between adjustment of an aperture area of the aperture stop and adjustment of the amount of transmitted light of the variable light transmission filter. Hence, it is possible to photograph images according to various kinds of intention in imaging. Through a turning operation of either one of the first operation ring and the second operation ring and a rotation of the other ring interlocking through the mechanism section, it is possible to adjust the depth of field by adjusting the aperture size of the aperture stop device while suppressing change in the amount of transmitted light. Thereby, through a manual operation, it is possible to easily obtain a blur condition of the background appropriate for the intention of the photographer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram schematically illustrating a configuration of an example of a lens device and an imaging device mounted with the lens device according to an embodiment of the present invention.

FIGS. **2**A and **2**B are diagrams illustrating configurations of the first operation ring and the second operation ring of the lens device of FIG. **1** and a mechanism section.

FIGS. **3**A and **3**B are diagrams illustrating transfer and blocking of rotations of the first operation ring and the second operation ring performed by the mechanism section of FIGS. **2**A and **2**B.

FIGS. **4**A and **4**B are graphs illustrating examples of relationships of the amounts of transmitted light relative to the respective amounts of operation (rotation angles) of the first operation ring and the second operation ring in the lens device of FIG. **1**.

FIGS. **5**A and **5**B are diagrams schematically illustrating a configuration of another example of a lens device according to an embodiment of the present invention.

FIGS. **6**A and **6**B are diagrams illustrating transfer of rotations of the first operation ring and the second operation ring performed by the mechanism section of FIGS. **5**A and **5**B.

FIG. **7** is a diagram schematically illustrating a configuration of a modified example of the lens device of FIGS. **5**A and **5**B.

FIGS. **8**A and **8**B are diagrams illustrating transfer of rotations of the first operation ring and the second operation ring performed by the mechanism section of FIG. **7**.

FIGS. **9**A, **9**B, and **9**C are diagrams schematically illustrating a configuration of another example of a lens device according to an embodiment of the present invention.

FIGS. **10**A and **10**B are diagrams illustrating transfer of rotations of the first operation ring and the second operation ring performed by the mechanism section of FIGS. **9**A and **9**B.

FIG. **11** is a diagram schematically illustrating a configuration of a modified example of the lens device of FIGS. **9**A and **9**B.

FIG. **12** is a diagram schematically illustrating a configuration of a mechanism section of the lens device of FIG. **11**.

FIGS. **13**A and **13**B are diagrams illustrating transfer of rotations of the first operation ring and the second operation ring performed by the mechanism section of FIG. **11**.

FIG. **14** is a functional block diagram of principal sections of an example of the imaging device according to the embodiment of the present invention.

FIG. **15** is a functional block diagram of principal sections of another example of the imaging device according to the embodiment of the present invention.

FIG. **16** is a functional block diagram of principal sections of another example of the imaging device according to the embodiment of the present invention.

FIG. **17** is a diagram illustrating a configuration of an example of a general aperture stop device that adjusts an aperture area.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a diagram schematically illustrating a configuration of an example of a lens device and an imaging device mounted with the lens device according to an embodiment of the present invention.

A lens device **2** is mounted on the front part of an imaging device main body **1**.

The lens device **2** has a lens barrel **10** that has a barrel shape such as a cylindrical shape. Into the lens barrel **10**, imaging-lenses such as a zoom lens and a focus lens and an aperture stop device capable of adjusting the aperture size are built. Further, in the present example, a variable light transmission filter is also built into the lens device **2**. A mount section **3** is provided on the base of the lens barrel of the lens device **2**. By detachably mounting a connection portion **3***a* of the mount section **3** on a lens mount section provided in the front part of the imaging device main body **1**, the lens device **2** is fixed onto the imaging device main body **1**.

In the connection portion **3***a*, various kinds of connection terminals (electric terminals), which are not shown, are provided. Further, in the lens mount section, connection terminals (electric terminals) corresponding to the various kinds of connection terminals on the lens device side are provided. By mounting the lens device **2** on the imaging device main body **1**, electric connection is made for each corresponding connection terminal. Thereby, a not-shown control unit (CPU) of the lens device **2** acquires necessary information of the imaging device main body **1** side. Further, the control unit (CPU) on the imaging device main body **1** side acquires necessary information of the lens device **2** side.

A photographer **5** views a finder device **6** with the right eye while carrying the imaging device main body **1** on the right shoulder. Further, the photographer **5** photographs a moving image of an object while fixing the imaging device by holding a grip portion of the lens device **2** with a right hand **7**. At this time, the photographer **5** operates various kinds of operation tools provided in the lens device **2** with the sense of touch of the left hand.

In the lens device **2**, for example, a focus position adjustment tool (focus ring **11**), which adjusts a focus position of a focus lens, is provided in a ring shape on the lens leading end side (object side) such that it can be turned around the outer circumference of the lens barrel **10**. By rotating the focus ring **11** to an arbitrary angle with the left hand, the photographer **5** adjusts the focus position.

In the middle part of the lens device **2**, the zoom position adjustment tool (zoom ring **12**), which adjusts a zoom position of a zoom lens, is provided in a ring shape such that it can be turned around the outer circumference of the lens barrel **10**. By rotating the zoom ring **12** to an arbitrary angle with the left hand, the photographer **5** adjusts a zoom ratio.

In the lens device **2**, on the side closer to the imaging device main body **1** than the zoom ring **12**, an aperture adjustment tool **13** of the aperture stop device and a light transmission adjustment tool **14** of the variable light transmission filter are provided. The adjustment tools **13** and **14** may be disposed to be adjacent to each other in a direction of the optical axis of the lens device **2**, and which one is disposed on the object side is optional.

The aperture stop position adjustment tool **13** of the aperture stop device is provided as an iris ring **13** such that it can be turned around the outer circumference of the lens barrel **10**. The light transmission adjustment tool **14** of the variable light transmission filter is formed as an ND filter ring **14** according to the shape of the iris ring **13** in the present embodiment, and is provided to be able to be turned around the outer circumference of the lens barrel **10**. The iris ring **13** and the ND filter ring **14** are provided to be parallel in a direction perpendicular to the optical axis and be rotatable about the same axis.

When a filter of a type adjusting the amount of transmission by a voltage as disclosed in JP2006-126504A is used as the variable light transmission filter, it is necessary to convert the rotation angle of the ND filter ring **14** into a voltage value. Hence, in this case, a potentiometer for rotation angle detection is mounted on an inner circumferential wall of the ND filter ring **14**.

The aperture stop device adjusted by the iris ring **13** and the variable light transmission filter adjusted by the ND filter ring **14** have in common a function of adjusting the amount of transmitted light, and also have in common the operational feel of both rings **13** and **14** at the time of adjusting the amount of transmitted light. That is, a relationship of an increase or a decrease of the amount of transmitted light relative to the rotation direction of the iris ring **13** is set to be the same as a relationship of an increase or a decrease of the amount of transmitted light relative to the rotation direction of the ND filter ring **14**.

For example, by rotating the iris ring **13** in the direction of the arrow A (refer to FIG. **3**), the aperture stop device is adjusted to increase the aperture size (to increase the amount of transmitted light). In addition, by rotating the ND filter ring **14** in the same direction, the variable light transmission filter is adjusted to increase the transmittance (to increase the amount of transmitted light).

Furthermore, the lens device **2** is provided with a mechanism section **15** that is engaged with the iris ring **13** and the ND filter ring **14** so as to transfer rotations of the rings **13** and **14** to each other and block the rotations of the rings **13** and **14**.

FIGS. **2**A and **2**B show configurations of the iris ring **13**, the ND filter ring **14**, and the mechanism section **15**.

The iris ring **13** and the ND filter ring **14** are disposed to be adjacent to each other with a predetermined distance therebetween in the optical axis direction of the lens device **2**, and the mechanism section **15** is disposed at a position between the iris ring **13** and the ND filter ring **14**.

In FIGS. **2**A and **2**B, the mechanism section **15** has a first gear mechanism **20**, which is formed of an odd number of gears, and a supporting portion **21** which supports the first gear mechanism **20**. In the example shown in the drawings, the first gear mechanism **20** is formed of a single gear **20***a* so as to rotatably support the gear **20***a*. Teeth meshed with the gear **20***a* are formed on each of the facing side surfaces of the iris ring **13** and the ND filter ring **14** between which the mechanism section **15** is interposed. It should be noted that the first gear mechanism **20** is configured to be supported by the supporting portion **21**. However, the first gear mechanism **20** and the supporting portion **21** may be integrally formed, and may constitute the first gear mechanism **20**.

The supporting portion **21** is supported by the lens barrel **10** so as to be movable in the diameter direction of the iris ring **13** and the ND filter ring **14**, and has an operation portion **22** which projects outside the iris ring **13** and the ND filter ring **14** in the diameter direction. A photographer performs an operation to push and pull the operation portion **22** in the diameter direction, whereby the mechanism section **15** is selectively disposed at a first position corresponding to the inside end of the movable range thereof in the diameter direction or a second position corresponding to the outside end of the movable range thereof in the diameter direction. The supporting portion **21** may have a structure which is capable of obtaining a click feeling when disposed at the first and second positions.

When the mechanism section **15** is disposed at the first position (FIG. **2**A), the gear **20***a* is meshed with each of the teeth **13***a* of the iris ring **13** and the teeth **14***a* of the ND filter ring **14**, and the first gear mechanism **20** is engaged with the iris ring **13** and the ND filter ring **14**.

When the mechanism section **15** is disposed at the second position (FIG. **2**B), the meshing of the gear **20***a* with the teeth **13***a* of the iris ring **13** and the teeth **14***a* of the ND filter ring **14** is released, and the engagement of the first gear mechanism **20** with the iris ring **13** and the ND filter ring **14** is released.

FIGS. **3**A and **3**B show transfer and blocking of the rotations of the iris ring **13** and the ND filter ring **14** performed by the mechanism section **15**. It should be noted that, in the drawings, the outlined arrow indicates a movement (rotation) direction of a driving element which is operated by the photographer, and the solid line arrow indicates a movement (rotation) direction of a driven element.

When the mechanism section **15** is disposed at the first position (FIG. **3**A), as described above, the first gear mechanism **20** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, when any one ring of the iris ring **13** and the ND filter ring **14** is turned, the rotation is transferred to the other ring through the first gear mechanism **20**. The first gear mechanism **20** is formed of an odd number of gears (the single gear **20***a* in the example shown in the drawings), and the rotation of one ring is reversed, and is transferred to the other ring. For example, when the iris ring **13** is turned in the direction of the arrow A, the rotation is reversed by the first gear mechanism **20**, and is transferred to the ND filter ring **14**, and the ND filter ring **14** rotates in a direction of the arrow B opposite to the direction of the arrow A. It should be noted that the first gear mechanism **20** may be formed of not only an odd number of gears but also an even number of gears. In this case, due to the turning operation of the iris ring **13**, the rotation is transferred, as rotation in the same direction, to the ND filter ring **14** by the first gear mechanism **20**, and thus the ND filter ring **14** rotates in the same direction as the iris ring **13**.

Since the relationship of the increase or the decrease of the amount of transmitted light relative to the rotation direction of the iris ring **13** is set to be the same as the relationship of the increase or the decrease of the amount of transmitted light relative to the rotation direction of the ND filter ring **14**, due to the turning operation of the iris ring **13** and reverse rotation of the ND filter ring **14** interlocking therewith, while suppressing the change in the amount of transmitted light, it is possible to adjust the depth of field by adjusting the aperture size of the aperture stop device. Thereby, for example, it is possible to easily obtain the blur condition of the background appropriate for an intention of the photographer even through a manual operation. In addition, as will be described in detail later, a correspondence relationship between a rotation angle of the iris ring **13** and a light amount ratio, which is a ratio of an amount of exit light to an amount of light incident into the aperture stop device, and a correspondence relationship between a rotation angle of the ND filter ring **14** and the transmittance of the variable light transmission filter are configured to be relations of geometrical progressions which are the same in terms of progressions of ratios of amounts of transmitted light at respective rotation angles based on an amount of unitary angular change. This configuration is desirable since it is possible to keep the amount of transmitted light constant in the above operation.

When the mechanism section **15** is disposed at the second position (FIG. **3**B), as described above, the engagement of the first gear mechanism **20** with the iris ring **13** and the ND filter ring **14** is released. Accordingly, the rotations of the iris ring **13** and the ND filter ring **14** are blocked from each other, and the iris ring **13** and the ND filter ring **14** are separately operable to be turned in both forward and reverse directions. Accordingly, by turning the iris ring **13** and the ND filter ring **14** in the same direction, both amounts of transmitted light of the aperture stop device and the transmittance variable filter are increased or decreased. As a result, it is possible to enhance adjustability of the amount of transmitted light. Thereby, for example, it is possible to perform imaging immediately in response to even an excessively large change in the luminance of the object relative to the adjustability of the amount of transmitted light of the aperture stop device. In particular, the iris ring **13** and the ND filter ring **14** are disposed to be adjacent to each other in the optical axis direction of the lens device **2**, and this configuration is appropriate for when both rings **13** and **14** are simultaneously turned.

FIGS. **4**A and **4**B are graphs illustrating examples of relationships of the amounts of transmitted light relative to the respective amounts of operation (rotation angles) of the iris ring **13** and the ND filter ring **14**.

The iris ring **13** is configured such that the amount of transmitted light of the aperture stop device is 50% at the rotation angle α to the origin position (at which the amount of transmitted light of the aperture stop device is 100%), the amount of transmitted light is 25% at the rotation angle 2α, the amount of transmitted light is 12.5% at the rotation angle 3α, the amount of transmitted light is 6.3% at the rotation angle 4α, . . . (FIG. **4**A). In order to obtain the same operational feel as the operational feel of the iris ring **13**, also in the ND filter ring **14**, the amount of transmitted light of the variable light transmission filter is set to 50% at the rotation angle α to the origin position (at which amount of transmitted light of the variable light transmission filter is 100%), the amount of transmitted light is set to 25% at the rotation angle 2α, the amount of transmitted light is set to 12.5% at the rotation angle 3α, the amount of transmitted light is set to 6.3% at the rotation angle 4α, . . . (FIG. **4**A). That is, a rotation direction, in which the aperture area of the aperture stop device is increased by the iris ring **13**, is the same as a direction in which the transmittance of the variable light transmission filter is increased by the ND filter ring **14**. In addition, the relationships of the amounts of transmitted light relative to the respective amounts of operation (rotation angle) of the iris ring **13** and the ND filter ring **14** are relationships of geometrical progressions which are the same in that a geometrical ratio is 1/2 in terms of progressions of ratios of amounts of transmitted light (100%, 50%, 25%, . . .) at respective rotation angles (origin, α, 2α, . . .) based on an amount of unitary angular change α.

For example, as disclosed in JP2006-126504A, when the amount of transmitted light of the variable light transmission filter is controlled on the basis of the voltage value applied to the filter, control voltage values corresponding to the rotation angles α, 2α, and 3α, . . . of the ND filter ring **14** are set, and the voltage values are applied to the electrodes of the variable light transmission filter, thereby achieving the amounts of transmitted light corresponding to the rotation angles.

Further, as will be described later, the amount of transmitted light of the variable light transmission filter is subjected to feedback control such that the relative relationship between the rotation angle of the ND filter ring **14** and the amount of transmitted light of the variable light transmission filter coincides with the relative relationship between the rotation angle of the iris ring **12** and the amount of transmitted light of the aperture stop device with high accuracy.

According to the above-mentioned relationships of the amounts of transmitted light relative to the respective amounts of operation (rotation angles) of the iris ring **13** and the ND filter ring **14**, due to the turning operation of the iris ring **13** and the reverse rotation of the ND filter ring **14** interlocking therewith through the mechanism section **15**, the amount of transmitted light is kept constant. It should be noted that in each graph of FIGS. **4**A and **4**B, the light amount points for each rotation angle α are connected by straight lines, but the effect thereof is the same even in the correspondence between the rotation angle and the light amount in which the points are connected by a curve.

FIGS. **5**A and **5**B show a configuration of another example of a lens device according to an embodiment of the present invention. It should be noted that the elements common to the above-mentioned lens device **2** are referenced by the same reference numerals and signs, and a description thereof will be omitted or simplified.

The lens device **102** shown in FIGS. **5**A and **5**B is different from the above-mentioned lens device **2** in that the mechanism section **15** is provided to be rotatable about the same axis as the iris ring **13** and the ND filter ring **14**.

The lens device **102** has a supporting ring **16** which is rotatably provided on the outer circumference of the lens barrel **10** at a position between the iris ring **13** and the ND filter ring **14**. The supporting ring **16** is provided to be rotatable about the same axis as the iris ring **13** and the ND filter ring **14**.

The supporting portion **21** of the mechanism section **15** is supported by the supporting ring **16** so as to be rotatable in the diameter direction of the iris ring **13** and the ND filter ring **14**. The mechanism section **15** is selectively disposed at a first position corresponding to the inside end of the movable range thereof in the diameter direction or a second position corresponding to the outside end of the movable range thereof in the diameter direction. At the first position (FIG. **5**A), the first gear mechanism **20** of the mechanism section **15** is engaged with the iris ring **13** and the ND filter ring **14**. At the second position (FIG. **5**B), the engagement of the first gear mechanism **20** of the mechanism section **15** with the iris ring **13** and the ND filter ring **14** is released.

Further, when a photographer turns the operation portion **22** around the rotation axis of the supporting ring **16**, the mechanism section **15**, in which the supporting portion **21** is supported by the supporting ring **16**, rotates around the rotation axis of the supporting ring **16** in accordance with the rotation of the supporting ring **16**.

FIGS. **6**A and **6**B show transfer of the rotations of the iris ring **13** and the ND filter ring **14** performed by the mechanism section **15**.

When the mechanism section **15** is disposed at the first position, the first gear mechanism **20** of the mechanism section **15** is engaged with the iris ring **13** and the ND filter ring

14. In this state, when any one ring of the iris ring **13** and the ND filter ring **14** is turned, the rotation thereof is reversed by the first gear mechanism **20**, and is transferred to the other ring (FIG. **6**A). Thereby, it is possible to adjust the depth of field by adjusting the aperture size of the aperture stop device while suppressing change in the amount of transmitted light.

Further, the first gear mechanism **20** of the mechanism section **15** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, the mechanism section **15** is turned around the rotation axis of the supporting ring **16**, that is, around the rotation axis of the iris ring **13** and the ND filter ring **14**, and then the iris ring **13** and the ND filter ring **14** rotate in the same direction at the same time (FIG. **6**B). Thereby, both amounts of transmitted light of the aperture stop device and the transmittance variable filter are increased or decreased. As a result, it is possible to enhance adjustability of the amount of transmitted light.

In the above-mentioned lens device **2**, in order to rotate the iris ring **13** and the ND filter ring **14** in the same direction at the same time, it is necessary to turn the two rings of the iris ring **13** and the ND filter ring **14** at the same time in the state where the mechanism section **15** is disposed at the second position. However, according to the lens device **102** of the present embodiment, simply the turning operation of the mechanism section **15** is sufficient, and thus operability is improved.

FIG. **7** shows a configuration of a modified example of the above-mentioned lens device **102**.

In the lens device **102** shown in FIG. **7**, the operation portion **22** of the mechanism section **15** is provided to extend in the diameter direction of the supporting ring **16** and to be twistable around the axis passing through the operation portion **22**. In addition, the operation portion **22** is connected to any one gear constituting the first gear mechanism **20**, and is configured to rotate the gear on its own axis in accordance with the twisting operation of the operation portion **22**. In the example shown in the drawing, the first gear mechanism **20** is formed of the single gear **20***a*, and the operation portion **22** is connected to the gear **20***a*.

FIGS. **8**A and **8**B show transfer of rotations of the iris ring **13** and the ND filter ring **14** performed by the mechanism section **15**.

When the mechanism section **15** is disposed at the first position, the first gear mechanism **20** of the mechanism section **15** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, when the operation portion **22** of the mechanism section **15** is twisted, in accordance with the twisting operation of the operation portion **22**, the gear **20***a* constituting the first gear mechanism **20** rotates on its own axis, and the rotation thereof is transferred to each of the iris ring **13** and the ND filter ring **14** engaged with the first gear mechanism **20**. Here, the first gear mechanism **20** is formed of an odd number of gears (the single gear **20***a* in the example shown in the drawings), and thus the rotation directions of the iris ring **13** and the ND filter ring **14** are opposite to each other. In other words, the rotation of the iris ring **13** is reversed by the first gear mechanism **20**, and is transferred to the ND filter ring **14**. Thereby, it is possible to adjust the depth of field by adjusting the aperture size of the aperture stop device while suppressing change in the amount of transmitted light.

Further, the mechanism section **15** is turned around the rotation axis of the supporting ring **16**, that is, around the rotation axis of the iris ring **13** and the ND filter ring **14**, and then the iris ring **13** and the ND filter ring **14** rotate in the same direction at the same time. Thereby, both amounts of transmitted light of the aperture stop device and the transmittance variable filter are increased or decreased. As a result, it is possible to enhance adjustability of the amount of transmitted light.

In the lens device **102** shown in FIGS. **5**A and **5**B, the iris ring **13** and the ND filter ring **14** may rotate in the same direction at the same time, and may rotate in the opposite directions at the same time. In the above cases, operation targets are different (in the former case, the mechanism section **15**, and in the latter case, the iris ring **13** or the ND filter ring **14**). In contrast, in the lens device **102** shown FIG. **7**, in either case, rotation can be caused by the operation of the mechanism section **15** (in the former case, by the turning operation of the entire mechanism section **15**, and in the latter case, by the twisting operation of the operation portion **22** of the mechanism section **15**), and thus operability is improved.

FIGS. **9**A and **9**B show a configuration of another example of a lens device according to an embodiment of the present invention. It should be noted that the elements common to the above-mentioned lens devices **2** and **102** are referenced by the same reference numerals and signs, and a description thereof will be omitted or simplified.

In the lens device **202** shown in FIGS. **9**A and **9**B, the mechanism section **15** has the first gear mechanism **20** that is formed of an odd number of gears, a second gear mechanism **23** that is formed of an even number of gears, and the supporting portion **21** that supports the first gear mechanism **20** and the second gear mechanism **23**. In the example shown in the drawing, the first gear mechanism **20** is formed of the single gear **20***a*, and the second gear mechanism **23** is formed of two gears **23***a* and **23***b*. Teeth meshed with the gear **20***a* of the first gear mechanism **20** and one gear **23***a* of the second gear mechanism **23** are formed on the side surface of the iris ring **13**. Teeth meshed with the gear **20***a* of the first gear mechanism **20** and the other gear **23***b* of the second gear mechanism **23** are formed on the side surface of the ND filter ring **14**.

The supporting portion **21** is supported by the lens barrel **10** so as to be movable in the diameter direction of the iris ring **13** and the ND filter ring **14**, and has the operation portion **22** which projects outside the iris ring **13** and the ND filter ring **14** in the diameter direction. A photographer performs an operation to push and pull the operation portion **22** in the diameter direction, whereby the mechanism section **15** is selectively disposed at a first position corresponding to the inside end of the movable range thereof in the diameter direction, a third position corresponding to the outside end of the movable range thereof in the diameter direction, or a second position that is positioned between the first position and the third position.

When the mechanism section **15** is disposed at the first position (FIG. **9**A), the gear **20***a* of the first gear mechanism **20** is meshed with each of the teeth **13***a* of the iris ring **13** and the teeth **14***a* of the ND filter ring **14**, and the first gear mechanism **20** is engaged with the iris ring **13** and the ND filter ring **14**.

When the mechanism section **15** is disposed at the third position (FIG. **9**B), one gear **23***a* of the second gear mechanism **23** is meshed with the teeth **13***a* of the iris ring **13**, and the other gear **23***b* is meshed with the teeth **14***a* of the ND filter ring **14**, and the second gear mechanism **23** is engaged with the iris ring **13** and the ND filter ring **14**.

When the mechanism section **15** is disposed at the second position (FIG. **9**C), the meshing of the gears **20***a* and **23***a* with the teeth **13***a* of the iris ring **13** is released, the meshing of the gears **20***a* and **23***b* with the teeth **14***a* of the ND filter ring **14** is released, and the engagement of the first gear mechanism

20 and the second gear mechanism **23** with the iris ring **13** and the ND filter ring **14** is released.

FIGS. **10**A and **10**B show transfer of the rotations of the iris ring **13** and the ND filter ring **14** performed by the mechanism section **15**.

When the mechanism section **15** is disposed at the first position (FIG. **10**A), as described above, the first gear mechanism **20** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, when any one ring of the iris ring **13** and the ND filter ring **14** is turned, the rotation is transferred to the other ring through the first gear mechanism **20**. The first gear mechanism **20** is formed of an odd number of gears (the single gear **20***a* in the example shown in the drawings), and the rotation of one ring is reversed, and is transferred to the other ring.

When the mechanism section **15** is disposed at the third position (FIG. **10**B), as described above, the second gear mechanism **23** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, when any one ring of the iris ring **13** and the ND filter ring **14** is turned, the rotation is transferred to the other ring through the second gear mechanism **23**. The second gear mechanism **23** is formed of an even number of gears (the two gears **23***a* and **23***b* in the example shown in the drawings), and the rotation of one ring is not reversed, and is transferred to the other ring as rotation in the same direction.

When the mechanism section **15** is disposed at the second position, as described above, the engagement of the first gear mechanism **20** and the second gear mechanism **23** with the iris ring **13** and the ND filter ring **14** is released. Accordingly, the iris ring **13** and the ND filter ring **14** are separately operable to be turned in both forward and reverse directions.

According to the above-mentioned configuration, the iris ring **13** and the ND filter ring **14** may rotate in the same direction at the same time, and may rotate in the opposite directions at the same time. In either case, rotation can be caused by the turning operation of any one ring of the iris ring **13** and the ND filter ring **14**, and thus operability is excellent.

FIGS. **11** and **12** show a configuration of a modified example of the above-mentioned lens device **202**.

In the lens device **202** shown in FIGS. **11** and **12**, the operation portion **22** of the mechanism section **15** is provided to extend in the diameter direction of the supporting ring **16** and to be twistable around the axis passing through the operation portion **22**. In addition, the operation portion **22** is connected to each of any one gear constituting the first gear mechanism **20** and any one gear constituting the second gear mechanism **23**, and is configured to rotate the gears on their own axes in accordance with the twisting operation of the operation portion **22**.

In the example shown in the drawing, the first gear mechanism **20** is formed of the single gear **20***a*, and the operation portion **22** is directly connected to the gear **20***a*. On the other hand, the second gear mechanism **23** is formed of the two gears **23***a* and **23***b*, and the axes of rotation of the gears **23***a* and **23***b* are different from the axis of rotation of the gear **20***a* of the first gear mechanism **20**. Therefore, the operation portion **22** is connected to one gear **23***a* of the second gear mechanism **23** through gears **24***a* and **24***b*.

FIGS. **13**A and **13**B show transfer of rotations of the iris ring **13** and the ND filter ring **14** performed by the mechanism section **15**.

When the mechanism section **15** is disposed at the first position (FIG. **13**A), the first gear mechanism **20** of the mechanism section **15** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, when the operation portion **22** of the mechanism section **15** is twisted, in accordance with the twisting operation of the operation portion **22**, the gear **20***a* constituting the first gear mechanism **20** rotates on its own axis, and the rotation thereof is transferred to each of the iris ring **13** and the ND filter ring **14** engaged with the first gear mechanism **20**. Here, the first gear mechanism **20** is formed of an odd number of gears (the single gear **20***a* in the example shown in the drawings), and thus the rotation directions of the iris ring **13** and the ND filter ring **14** are opposite to each other.

When the mechanism section **15** is disposed at the third position (FIG. **13**B), the second gear mechanism **23** of the mechanism section **15** is engaged with the iris ring **13** and the ND filter ring **14**. In this state, when the operation portion **22** of the mechanism section **15** is twisted, in accordance with the twisting operation of the operation portion **22**, the gear **23***a* constituting the second gear mechanism **23** rotates on its own axis, and the rotation thereof is transferred to each of the iris ring **13** and the ND filter ring **14** engaged with the second gear mechanism **23**. The second gear mechanism **23** is formed of an even number of gears (the two gears **23***a* and **23***b* in the example shown in the drawings), and the directions of the rotations of the iris ring **13** and the ND filter ring **14** are made to be the same.

According to the above-mentioned configuration, the iris ring **13** and the ND filter ring **14** may rotate in the same direction at the same time, and may rotate in the opposite directions at the same time. In either case, rotation can be caused by the twisting operation of the operation portion **22** of the mechanism section **15**, and thus operability is excellent.

FIG. **14** is a functional block diagram of principal sections of the whole imaging device in which the above-mentioned lens device **2** is mounted on the imaging device main body **1**.

Into the lens device **2**, imaging-lenses **31** and **32**, an aperture stop device **33** that adjusts the aperture size (aperture area) as shown in for example FIG. **17**, and a variable light transmission filter **34** are built. In this example, the aperture stop device **33** and the variable light transmission filter **34** are disposed to be close, but the aperture stop device **33** and the variable light transmission filter **34** may be separately disposed at different locations on the optical path of the incident light.

A dashed line circle X shown in FIG. **14** indicates an outer circumferential portion of the lens barrel **10** of the lens device **2**. On the outer circumferential portion of the lens device **2**, the iris ring **13**, which adjusts the aperture size of the aperture stop device **33**, and the ND filter ring **14**, which adjusts the amount of transmitted light of the variable light transmission filter **34**, are disposed to be adjacent. The amount of rotation of the iris ring **13** is converted into a driving force in a direction (or an opposite direction) of an arrow **104** shown in FIG. **17** of the aperture stop device **33** through a mechanical or electrical driving mechanism.

On the inner circumferential portion of the ND filter ring **14**, a potentiometer **35**, which detects the amount of operation (rotation angle) of the ND filter ring **14**, is provided. An ND filter control section **36** reads the rotation angle which is detected by the potentiometer **35**, applies a voltage value according to the rotation angle to an electrode of the variable light transmission filter **34**, and controls the amount of transmitted light.

A transmittance monitor **37** is disposed in the vicinity of the variable light transmission filter **34**. The transmittance detected by the monitor **37** is fed back to the ND filter control section **36** and is subjected to feedback control so as to be the transmittance (amount of transmitted light) according to the rotation angle detected by the potentiometer **35**.

The transmittance monitor **37** is formed of a light emitting element and a light receiving element, between which the circular disc of the variable light transmission filter **34** is interposed, so as to detect the transmittance of the variable light transmission filter **34** on the basis of the amount of light emitted by the light emitting element and the amount of light received by the light receiving element.

Into the imaging device main body **1**, an imaging device module **38** is built. The imaging device module **38** shown in the drawing is formed of: a prism **38***a* that separates the incident light transmitted through the lens device **2** into optical paths of three colors of red (R), green (G), and blue (B); an imaging device **38**R that detects red light (R light) separated by the prism **38***a*; an imaging device **38**G that detects green light (G light) separated by the prism **38***a*; and an imaging device **38**B that detects blue light (B light) separated by the prism **38***a*.

The detection signals of the respective imaging devices **38**R, **38**G, and **38**B are subjected to white balance correction by a camera image processing section (CAM) **39**, and are then output as, for example, television signals.

A camera image processing section **21** feeds a captured image signal, which is captured by the imaging device module **38**, as light amount information back to the ND filter control section **36** of the lens device **2**. The ND filter control section **36** controls the transmittance of the variable light transmission filter **34** in consideration of also the fed-back information.

Further, it is ideal that the variable light transmission filter **34** keep the transmittance constant at all wavelengths in a imaging wavelength region without wavelength dependency in the transmittance. However, practically the balance of RGB is slightly different, and thus as the transmittance is changed, the balance of RGB is slightly changed. Hence, it is desirable that the camera image processing section **21** acquire the transmittance information from the ND filter control section **36**, and perform white balance correction on the basis of the correction value which is preset using the transmittance information. The preset correction value can be obtained by photographing a white object with a light source having a constant intensity while changing the transmittance of the variable light transmission filter **34**.

It should be noted that, in the imaging device of FIG. **14**, the imaging device mounted on the imaging device main body **1** is a three-plate imaging device, but may be a single-plate imaging device.

FIG. **15** is a functional block diagram of principal sections of another example of the imaging device.

In the imaging device shown in FIG. **14**, as the variable light transmission filter, for example, the filter, which controls the amount of transmitted light through voltage value control exemplified in JP2006-126504A, is used, but the filter exemplified in JP2007-243928A may be used. The filter forms gradation on a transparent circular disc by using a dimming material. That is, the filter is manufactured in a state where the density of the dimming material is adjusted such that, as the rotation angle increases, the transmittance gradually increases, where the transmittance is 0% at the position of the rotation angle of 0 degrees to the central axis and the transmittance is 100% at the position right before the rotation angle of 360 degrees.

The variable light transmission filter **40** is built into the lens device **2**, together with the aperture stop device **33**. In addition, the ND filter control section **36** issues a command to a motor **41** in accordance with the rotation angle which is detected by the potentiometer **35**, and thereby controls the rotation angle position of the filter **40**. Thereby, the depth of gradation on the incident light optical path of the filter **40** becomes a desired depth, and the amount of light transmitted through the filter according to the rotation position of the ND filter ring **14** is obtained. In this configuration, the gradation position of the filter **40** is determined depending on the rotation angle of the filter **40**. Hence, it is not necessary to provide a feedback control system using the transmittance monitor **37** of FIG. **14**.

FIG. **16** is a functional block diagram of principal sections of another example of the imaging device.

As described above, the operation tool (iris ring **13**) of the aperture stop device **33** of which the aperture size is variable and the operation tool (ND filter ring) **14** of the variable light transmission filter are disposed on the outer circumferential portion of the lens device **2** so as to be adjacent to each other. However, it is not always necessary for the aperture stop device and the variable light transmission filter to be disposed to be close to each other.

In the imaging device shown in FIG. **16**, there is the lens device **2** mounted on the imaging device main body **1** that has the built-in imaging device provided with the variable light transmission filter. In front of the imaging devices **38**R, **38**G, and **38**B, the variable light transmission filters **38***r*, **38***g*, and **38***b* are disposed, respectively. The transmittances of the variable light transmission filters **38***r*, **38***g*, and **38***b* are controlled by the amount of operation (rotation angle) of the ND filter ring provided on the lens device **2** side.

The potentiometer **35** that detects the amount of rotation is mounted on the ND filter ring. In addition, the ND filter control section **36** is configured to transfer the detected value of the amount of rotation to a transmission adjustment circuit **43** on the imaging device main body **1** side. The transmission adjustment circuit **24** controls the transmittances of the variable light transmission filters **38***r*, **38***g*, and **38***b* in accordance with the detected value of the potentiometer **35**.

In the imaging device shown in FIG. **16**, the variable light transmission filter may be built into the lens device **2**. It may be possible to adopt a configuration in which whether to use the variable light transmission filter on the imaging device main body **1** side or to use the variable light transmission filter built into the lens device **2** is selected by a switch provided in the lens device **2** and not shown in the drawing. When the variable light transmission filter built into the lens device **2** is not used, the transmittance of the variable light transmission filter is set to 100%. The ND filter control section **36** may have a configuration for performing only the function of simply transferring the detected value of the potentiometer **35** to the imaging device main body **1** side.

As described above, in the present specification, a lens device of (1) to (10) to be described as follows is disclosed, and an imaging device of (11) to be described as follows is disclosed.

(1) a lens device for an imaging device having a imaging-lens and an aperture stop device that adjusts an aperture area, the lens device including: a lens barrel that houses the imaging-lens and the aperture stop device; a first operation ring that is provided on an outer circumferential portion of the lens barrel at a desired position and is provided to be rotatable in a circumferential direction of the outer circumferential portion about an axis line of the lens barrel as a rotation axis in order to adjust the aperture area of the aperture stop device; a second operation ring that is provided in parallel with the first operation ring and provided to be rotatable in the circumferential direction of the outer circumferential portion about the axis line of the lens barrel as the rotation axis in order to adjust a transmittance of a variable light transmission filter; and a mechanism section that transfers rotations of the first operation ring and the second operation ring to each other and blocks the rotations, in which a rotation direction, in which

the aperture area of the aperture stop device is increased by the first operation ring, is the same as a rotation direction in which the transmittance of the variable light transmission filter is increased by the second operation ring, and in which the mechanism section is configured to be able to convert the rotations of the first operation ring and the second operation ring into rotations in directions the same as each other or directions opposite to each other and transfer the rotations.

(2) The lens device according to (1), in which the mechanism section has a first gear mechanism, which is formed of gears, and a supporting portion which supports the first gear mechanism, and in which the supporting portion is provided to be movable, along diameter directions of the first operation ring and the second operation ring, to a plurality of positions that includes a first position, at which the first gear mechanism is engaged with each of the first operation ring and the second operation ring, and a second position at which engagement of the first gear mechanism with each of the first operation ring and the second operation ring is released.

(3) The lens device according to (2), in which the mechanism section is configured to be able to transfer the rotations of the first operation ring and the second operation ring as rotations in the directions the same as each other.

(4) The lens device according to (3), in which the supporting portion has an operation portion that is provided to be operable to revolve around rotation axes of the first operation ring and the second operation ring and causes any one of the gears of the first gear mechanism to rotate on its own axis.

(5) The lens device according to (3), in which the mechanism section further has a second gear mechanism which is formed of gears supported by the supporting portion, and in which the plurality of positions, to which the supporting portion is movable, further includes a third position at which the second gear mechanism is engaged with each of the first operation ring and the second operation ring.

(6) The lens device according to (5), in which the supporting portion has an operation portion that causes any one of the gears of the first gear mechanism and any one of the gears of the second gear mechanism to rotate on their own axes.

(7) The lens device according to any one of (1) to (6), in which a correspondence relationship between a rotation angle of the first operation ring and a light amount ratio, which is a ratio of an amount of exit light to an amount of light incident into the aperture stop device, and a correspondence relationship between a rotation angle of the second operation ring and the transmittance of the variable light transmission filter are relations of geometrical progressions which are the same in terms of progressions of ratios of amounts of transmitted light at respective rotation angles based on an amount of unitary angular change.

(8) The lens device according to any one of (1) to (7), in which the variable light transmission filter is mounted on the lens barrel.

(9) The lens device according to (8), further including: a monitor that detects the transmittance of the variable light transmission filter; and a control section that performs feedback control on the transmittance of the variable light transmission filter and sets the transmittance, which is detected by the monitor, as a transmittance depending on an amount of an operation of the second operation ring.

(10) The lens device according to any one of (1) to (7), in which the control section in the imaging device transmits a signal based on the amount of the operation of the second operation ring to the imaging device, and controls the transmittance of the variable light transmission filter provided in the imaging device.

(11) An imaging device including the lens device according to any one of (1) to (10).

What is claimed is:

1. A lens device for an imaging device having a imaging-lens and an aperture stop device that adjusts an aperture area, the lens device comprising:

a lens barrel that houses the imaging-lens and the aperture stop device;

a first operation ring on an outer circumferential portion of the lens barrel at a desired position and that is rotatable in a circumferential direction of the outer circumferential portion about an axis line of the lens barrel as a rotation axis in order to adjust the aperture area of the aperture stop device;

a second operation ring in parallel with the first operation ring and that is rotatable in the circumferential direction of the outer circumferential portion about the axis line of the lens barrel as the rotation axis in order to adjust a transmittance of a variable light transmission filter; and

a mechanism section that switches between an engagement state of the first operation ring and the second operation ring in which rotation of the first operation ring and the second operation ring are transferred to each other, and a non-engagement state of the first operation ring and the second operation ring in which the transfer of the rotation is blocked,

wherein a rotation direction, in which the aperture area of the aperture stop device is increased by the first operation ring, is the same as a rotation direction in which the transmittance of the variable light transmission filter is increased by the second operation ring, and

wherein the mechanism section is configured to convert the rotations of the first operation ring and the second operation ring into rotations in directions the same as each other or directions opposite to each other.

2. The lens device according to claim **1**,

wherein the mechanism section has a first gear mechanism, which is formed of gears, and a supporting portion which supports the first gear mechanism, and

wherein the supporting portion is provided to be movable, along diameter directions of the first operation ring and the second operation ring, to a plurality of positions that includes a first position, at which the first gear mechanism is engaged with each of the first operation ring and the second operation ring, and a second position at which engagement of the first gear mechanism with each of the first operation ring and the second operation ring is released.

3. The lens device according to claim **2**,

wherein the supporting portion has an operation portion that is adapted to revolve around rotation axes of the first operation ring and the second operation ring and causes any one of the gears of the first gear mechanism to rotate on its own axis, and

wherein the mechanism section is configured to be able to transfer the rotations of the first operation ring and the second operation ring as rotations in the directions the same as each other.

4. The lens device according to claim **2**,

wherein the mechanism section further has a second gear mechanism which is formed of gears supported by the supporting portion, and

wherein the plurality of positions, to which the supporting portion is movable, further includes a third position at which the second gear mechanism is engaged with each of the first operation ring and the second operation ring, and wherein the mechanism section is configured to be able to transfer the rotations of the first operation ring and the second operation ring as rotations in the directions the same as each other.

5. The lens device according to claim **4**, wherein the supporting portion has an operation portion that causes any one of the gears of the first gear mechanism and any one of the gears of the second gear mechanism to rotate on their own axes.

6. The lens device according to claim **2**, wherein the variable light transmission filter is mounted on the lens barrel.

7. The lens device according to claim **6**, further comprising:

a monitor that detects the transmittance of the variable light transmission filter; and

a control section that performs feedback control on the transmittance of the variable light transmission filter and sets the transmittance, which is detected by the monitor, as a transmittance depending on an amount of an operation of the second operation ring.

8. The lens device according to claim **7**, wherein the control section in the imaging device transmits a signal based on the amount of the operation of the second operation ring to the imaging device, and controls the transmittance of the variable light transmission filter provided in the imaging device.

9. An imaging device comprising the lens device according to claim **2**.

10. The lens device according to claim **1**, wherein the variable light transmission filter is mounted on the lens barrel.

11. The lens device according to claim **10**, further comprising:

a monitor that detects the transmittance of the variable light transmission filter; and

a control section that performs feedback control on the transmittance of the variable light transmission filter and sets the transmittance, which is detected by the monitor, as a transmittance depending on an amount of an operation of the second operation ring.

12. The lens device according to claim **11**, wherein the control section in the imaging device transmits a signal based on the amount of the operation of the second operation ring to the imaging device, and controls the transmittance of the variable light transmission filter provided in the imaging device.

13. An imaging device comprising the lens device according to claim **1**.

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